LIST OF THE OFFICERS

OF

The Institution of Petroleum Technologists,

1931-1932.

Past Presidents:

*Sir Boverton Redwood, Bart., D.Sc., F.R.S.E. (1914-1916).
Prof. Sir John Cadman, G.C.M.G., D.Sc., M.Inst.C.E., M.Inst.M.M. (1916-1917)
The Rt. Hon. Lord Greenway of Standbridge Earle (1917-1919).
*Sir Frederick W. Black, K.C.B., B.A. (Lond.) (1919-1921).
Prof. John Samuel Strafford Brame, C.B.E., F.I.C., F.C.S. (1921-1923).
Herbert Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst.Mar.Eng. (1923-1925).
Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S. (1925-1927).
Alfred C. Adams (1927-1929).
A. E. Dunstan, D.Sc., F.I.C., F.C.S. (1929-1931).

President:

James Kewley, M.A., F.I.C., F.C.S.

Vice-Presidents:

Sir John T. Cargill, Bart., Hon. LL.D.
A. E. Chambers, A.M.Inst.C.E.
T. Dewhurst, A.R.C.Sc., F.G.S.
Alexander Duckham, F.C.S.
Arthur W. Eastlake, M.I.Min.E., A.M.I.Mech.E.
Robert Redwood, F.C.S.
A. Beeby Thompson, O.B.E., M.I.Mech.E., M.Inst.M.M., F.G.S.

Members of Council:

Ashley Carter, A.M.I.Mech.E.
G. H. Coxon.
A. Frank Dabell, M.I.Mech.E.
C. Dalley, M.I.E.E.
B. J. Ellis.
F. H. Garner, Ph.D., M.Sc., F.I.C.
T. R. H. Garrett, M.A., F.G.S.
John Gillespie, M.I.Mech.E.
Prof. V. C. Illing.
J. S. Jackson, B.Sc., A.I.C.
Prof. A. W. Nash, M.Sc., F.C.S., M.I.Mech.E.
J. McConnell Sanders, F.I.C., F.C.S.
William Sutton, M.I.Min.E.
F. B. Thole, D.Sc., F.I.C., F.C.S.
A. Wade, D.Sc., A.R.C.S., F.G.S., M.Inst.M.M., F.Am.G.S.

Honorary Treasurer: Lord Plender of Sundridge, G.B.E.
Solicitors: Messrs. Ashurst, Morris, Crisp & Co.
Auditors: Messrs. Price Waterhouse & Co.

* Deceased.

Bankers:
WESTMINSTER BANK, LIMITED.
21, Lombard Street, London, E.C. 3.

Hon. Editor:
A. E. DUNSTAN, D.Sc., F.I.C., F.C.S.

Assistant-Editor and Secretary, Standardisation Committee
GEORGE SELL.

Hon. Secretary:
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.

Secretary:
Commander R. E. STOKES-REES, R.N.

Librarian:
Miss CLARE DESPARD.

Offices—Aldine House, Bedford Street, Strand, London, W.C. 2.

Telegrams: Instpetech, Westrand, London.
Telephone: Temple Bar 1842.

CONTENTS.

	PAGE
Council and Officers	i-ii
General Notices	iv-vi
Personal Notes and Special Notices	vi-x
Annual Report of the Council, 1930-1931	191
Eighteenth Annual General Meeting	200
Hydrated Lime and Diatomaceous Earth ("Diatomite") in Oil Well Cement. By ALEXANDER REID, M.A., B.Sc.	211
The Catalytic Addition of Gaseous Hydrochloric Acid to Unsaturated Hydrocarbons. By W. J. PIOTROWSKI and J. WINKLER	225
A Constant Level Consumption Meter for Lamps. By R. DOWNER, B.Sc.	242
Current Petroleum Notes	246
Reviews	247
Books Received	250

ABSTRACTS

	PAGE		PAGE
Geology	191A	Cracking	230A
Field Technology	192A	Hydrogenation	235A
Crude Oil	202A	Chemistry of Petroleum ..	237A
Natural Gas	205A	Analysis and Testing ..	242A
Motor Fuels	208A	Anti-Detonation	247A
Lubricants and Wax ..	212A	Engines	249A
Fluxes and Asphalts ..	217A	General	251A
Special Products	222A	Coal and Shale	254A
Refining and Refinery Plant ..	226A		

AUTHOR INDEX.

The numbers refer to the Abstract Number.

Albert G.m.b.H., K., 542
Aldrich, E. W., 589
Allen, T. W., 525, 526
Atlantic Refining Co., 492
Auer, J. L., 543

Baker, W. L., 471
Barkelew, J. T., 485
Baylis, W. L., 493, 494
Benner, H. P., 569
Bennie, R. J., 528
Bjerregaard, A. P., 555
Black, L. C., 480
Blackwood, A. J., 600
Blozam, A. G., 501
Boggs, C. R., 509
Borgstrom, P., 582
Bost, R. W., 561
Boyer, W. C., 502
Boyd, T. A., 597
Bridgeman, O. C., 589, 602
Bronn, J., 507
Bragmann, E. W., 535
Brunschwig, R., 504
Bruson, H. A., 542
Buerger, C. B., 574

C. & C. Developing Co., 571
Campbell, J. M., 597
Cash, G., 517
Cerini, W. E., 498
Chemical Reactions, Ltd., 576
Chr. Hostmann - Steinberg'sche, 537
Clark, L. H., 554
Compagnie Provencale de Raffinage, 516
Conn, W. M., 581
Cooley, J. L., 573
Crandall, G. S., 504
Crow, J., 577
Cummings, L. W. T., 535

Dangl, F., 588
Davenport, J. E., 510
Davis, H. S., 504
Davis, J. D., 515
De Vries, T., 536
Decker, L. V., 464
Dunkerley, W., 590

Egloff, G., 490, 562, 563, 569, 570
Elkington, H. D., 529, 533
Evans, R. N., 510

Farnham, H. H., 467
Ferris, T. W., 492
Fevre, E. C., le, 500
Filtrol Co., 493, 494
Forrest, H. O., 535
Forrow, E. W., 486
Forster, A. L., 550
Foster Wheeler Corpn., 560

Gallagher, H. F., 519
Gersterberger, D. F., 503
Gignoux, J. L., 470
Gloag, V. F., 609
Gordon, K., 577
Grisbaum, L. D., 518
Grounds, A., 468
Groves, H. E., 528
Groves, W. W., 545
Gulf Refining Co., 574

Hard, E. W., 465
Harrison, A. D., 553
Haslam, R. T., 502
Henri, V., 561
Herthel, E. C., 565
Higbee, W. E., 594
Hofmann, F., 566
Holt, S., 583
Holzmann, E., 579
Hough, J. F., 478
Howard, W. B., 568
Huff, L., 572
Hurd, C. D., 585

I. G. Farbenind. A.-G., 538, 539, 545–547, 552
Imperial Chemical Industries, Ltd., 577
Ipatiev, V. M., 575
Irey, K. M., 515

Jacque, L., 504
Jakowsky, J. J., 571
Jambuserwala, J., 583
Johnson, J. Y., 508, 538, 546–548, 552

Kallam, F. L., 497
Kauffman, H. L., 513
Kaura, B. D., 586
Kendall, Y. V., 603
Kirschbraun, L., 567
Kitchin, D. W., 509
Kobayashi, K., 580
Krase, N. W., 593
Ladigina, L. V., 587
Landes, W., 559
Larson, C. M., 512
Leglise, P., 601
Likhachev, N. D., 586
Linder, E. G., 592
Logan, L., 605
Lovell, W. G., 597
Lynch, W. C., 469

MacClatchie, J. W., 483
Macdonald, W. B., 470
Mackey, B. H., 593
Manley, R. E., 520
Martin, H., 595
Martin, W. L., 482
Mason, F. A., 583
McIntire, J. C., 582
Meinert, R. N., 585
Mejani, A., 607
Mills, B., 473
Morrell, J. C., 570
Moser, F. R., 495

N. V. de Bataafsche Petr. Mij., 495, 531–533
Nelson, E. F., 490, 562, 563
Nelson, W. R., 578
Newman, A. B., 599
Newton, R. F., 536

Orlov, N. A., 586

Panyity, L. S., 476
Pease, R. N., 584
Percival, S., 537
Peters, H. S., 596
Peters, K., 534
Petroleum Conversion Corpn., 491
Petroleum Laboratories, 564
Pickard, H., 530
Pilat, S., 579
Pogue, J. E., 604
Pollock, J. E., 591
Poole, J. W., 514
Primrose, J., 560

Rabl, A., 511
Reed, C. E., 484
Rickles, N. H., 600
Ritchie, K. S., 474
Roux, C. A. A. M., 606

Saladini, B., 521
Santiago, J. J., 489
Sergescu, B., 466
Sinclair Refining Co., 565
Skinner, D. G., 608
Slocum, J. H., 481
Smith, L. E., 477
Smith, S. S., 505
Soc. d'Etudes et 'Realisation dite "Ereal," 544
South Metro. Gas Co., 530
Speller, F. N., 603
Spencer, A. C., 556
Spielmann, P. E., 524
Stacey, H. R., 598
Stadnichenka, T., 463
Standard Oil Co., 517, 573
Standard Oil Development Co., 519, 556, 557
Stelk, K. T., 557
Stone, F., 488
Stratford, W. M., 558

Tausz, J., 511
Texas Co., 520, 558
Torrey, P. D., 475
Tronov, B. V., 587
Truesdell, P., 490, 562, 563
Turner, S. D., 591
Tweedy, S., 506

Union Chimique Belge S.A., 541
Universal Oil Products Co., 567–570, 572

Versluys, J., 462

Wagner, C. R., 540
Wagner, O. H., 534
Water, F. C. V., 564
Weiss, J. M., 527
White, A. F., 487
White, H. S., 602
Wiegand, W. B., 490, 509
Wilhelmi, R., 523
Williams, N., 472
Woollam, J. P. V., 609
Wulff, C., 566

Yamamata, K., 580
Young, H. A., 549

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS

NOTICES.

The Institution as a body is not responsible for the statements of opinion expressed in any of its publications.

Copyright. Authors of papers and articles are requested to transfer their copyright to the Institution for a period of six months from the date of receipt of the paper. Such transfer should be made in writing when the manuscript is forwarded to the Editor.

Editors are permitted to publish abstracts, providing that acknowledgment is made to The Institution of Petroleum Technologists.

Issue of Journal. The Journal is issued in twelve parts per volume, commencing in January of each year. The Title Page, Table of Contents and Index to each volume are published in the second issue of the succeeding volume.

Members whose subscription is not in arrear receive the Journal free of cost, and additional copies are charged at the rate of 7s. 6d. per part, unless otherwise stated. A member whose subscription is not paid by March 31st of the year for which it is due is considered to be in arrear.

Changes of Address. Members are requested to notify any change of address to the Secretary.

Papers and Articles. Members are invited to submit papers to be read at the General Meetings of the Institution, and are specially asked to forward articles for consideration for publication in the Journal. Diagrams, illustrations, etc., should be suitable for direct photographic reproduction. Authors are informed that all papers, whether for reading or for publication, will be submitted to a referee nominated by the Publication Committee.

Authors of papers published in the Journal are entitled to receive 25 free reprints of their contribution. Further copies may be obtained on payment, and orders for these should be sent to the Secretary when the manuscript is forwarded to the Editor. The free reprints do not include any discussion which may be published with the paper, but authors may have such discussion included in their reprints on payment of the additional cost.

Galley proofs of the paper to be read at a General Meeting are available at the time of the meeting, but members desirous of receiving such galley proofs in advance should apply to the Secretary.

Binding of Journals. Members desiring to have their Journals bound in cases should send them, together with a remittance of 5s. 6d. per volume, to Messrs. Speaight & Sons, Ltd., 98, Fetter Lane, London, E.C. 4. A charge of 7s. 6d. will be made for binding Vol. 10, 1924. Remittance in all cases must accompany the order.

Abstracts. Abstracts of the more important articles and patent specifications are published with each issue of the Journal, this supplement being paged independently of the transactions. Members desiring to have the Abstracts printed on one side of the paper only can be supplied with these at a charge of 10s. per annum per copy, payable in advance.

Medals. The Redwood Medal is awarded, at the discretion of the Council, to the person who shall have made the most meritorious contribution to petroleum technology, in the form of a paper or papers published in the Journal of the Institution, during two successive sessions, preference being given to original work and to papers which have been read before the Institution and discussed. The award is not confined to members of the Institution and may be withheld if no contribution is considered to be of sufficient merit.

A medal and a prize of five guineas is awarded annually by the Council to that Student Member of the Institution who shall, in their opinion, have presented the best paper during the session.

Benevolent Fund. The Benevolent Fund is intended to aid necessitous persons who are or have been members of the Institution, and their dependent relatives.

The Fund is raised by voluntary annual subscriptions, donations, and bequests, and all contributions should be sent to the Secretary of the Institution at Aldine House, Bedford Street, London, W.C. 2. The Fund is administered by the Council through the Benevolent Fund Committee, and all applications in connection therewith must be made on a special form which can be obtained from the Secretary of the Institution.

Appointments Register. A register of members requiring appointments is kept at the office of the Institution for the convenience of firms requiring the services of petroleum technologists, etc., it being understood that the Institution accepts no responsibility and gives no guarantee.

Library. The Institution's Library may be consulted between the hours of 11 a.m. and 4 p.m. daily. (Saturdays, 11 a.m. to 12 noon.)

Advertisements. Advertisements are inserted in the Journal, and information as to terms, etc., can be obtained from Mr. Thomas Tofts, 301-302, Bank Chambers, 329, High Holborn, W.C. 1. (Telephone No. Hol. 4776.)

LIST OF ADVERTISERS.

Members are desired when making enquiries or placing orders with advertisers to mention that they have seen their announcement in the Journal.

ANGLO-AMERICAN OIL CO., LTD.
W. CHRISTIE & GREY, LTD
A. F. CRAIG & CO., LTD.
FOSTER WHEELER, LTD.
W. J. FRASER & CO., LTD.
FAWCETT & CHALMERS ENG. WORKS
HADFIELDS LTD.
HAYWARD-TYLER & CO., LTD.
NATIONAL SUPPLY CORPORATION.
OIL WELL SUPPLY CO.
JOHN G. STEIN & CO., LTD.
STEWARTS AND LLOYDS, LTD.
SULLIVAN MACHINERY CO. (INC.).
THE TINTOMETER, LTD.
WALMSLEY, J.
WIRTH, ALFRED

PERSONAL NOTES OF MEMBERS AND SPECIAL NOTICES.

It is suggested that members send information regarding their movements to the Secretary, for insertion under this heading.

Mr. W. DUFF has left Rumania and is now in Sweden.
Mr. A. J. GOODMAN is in Canada.
Captain J. A. GOODWIN is home from Trinidad.
Mr. R. J. HAYMAN is coming home from Assam.
Mr. J. C. HOPE is returning from Burma.
Mr. F. L. HUNTER has returned to Rumania.
Mr. F. R. KELLY is home from Venezuela.
Mr. S. L. V. MAINPRISE is home from Burma.
Mr. D. J. PULL has returned to Persia.
Mr. J. W. REID has left Iraq and returned to Persia.
Mr. L. C. STEVENS is in Holland.
Mr. J. C. TEMPLETON is home from Iraq.
Mr. J. W. WEITZ has left for South Africa.

The Secretary would be glad to hear of the whereabouts of the following members:—C. A. BAUDUIN, A. E. O. COOKE, J. M. DALZELL, W. J. HARRIS, L. B. HOLLOWAY, C. E. JOBLING, Major E. T. NEWTON-CLARE, A. F. C. PARKER, NAND LAL PASI, W. E. SHEPHERD, E. V. SWAIN, R. K. VAN SICKLE, F. E. G. WATSON and A. O. WESTWOOD.

DINNER CLUB.

The attention of members is drawn to the Dinner Club of the Institution. This Club holds informal dinners after each General Meeting of the Institution and members may invite guests. Those desiring to receive notice of these dinners are requested to inform the Secretary of the Institution.

THIRTEENTH ANNUAL DINNER.

THE THIRTEENTH ANNUAL DINNER of the Institution of Petroleum Technologists will be held at the Connaught Rooms, London, on October 9th, 1931.

APPARATUS AND EQUIPMENT FOR GEOPHYSICAL SURVEYING.

A Special Exhibition of Apparatus and Equipment used in Geophysical Surveys was opened at the Science Museum, South Kensington, on March 21st, and will remain on view for a period of three months.

The exhibits have been specially selected to illustrate the development of all the important methods at present employed in the location of mineral deposits by the use of sensitive physical apparatus, as well as the evolution of the instruments and apparatus used. Details of field operations and the technique of the various methods are also represented, while in addition many examples are shown of results obtained by Geophysical Surveys in various parts of the World. Several of these results, which are now made public for the first time, demonstrate in a striking manner the possibilities of Geophysical methods of Exploration, in revealing the characteristic features of subterranean structures and mineral deposits.

CONGRESS ON LUBRICATION.

A Congress on Lubrication will be held in Strasbourg, July 20th to 26th, 1931, and it is proposed to deal with the following aspects of the subject:—

Study of Oils.—Definition; methods of testing; measuring apparatus; physical and chemical properties; etc.

Production of Oils.—Distillation and fractionation; refining; de-waxing; production of lubricating oils by cracking and hydrogenation; vegetable, animal and synthetic oils; solid lubricants; reclamation; etc.

Utilisation.—Theory of lubrication ; internal combustion engines ; steam engines and turbines ; locomotives ; transformers ; compressors ; textile industries ; etc.

Papers submitted should be confined to scientific and technical considerations and should be sent to the Secrétariat du Congrès du Graissage, 85, Boulevard du Montparnasse, Paris, 6e, not later than June 1st, 1931, together with a résumé in French.

A series of excursions are being arranged for during the Congress.

NOMINATIONS FOR MEMBERSHIP OF THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following have been nominated for membership of the Institution of Petroleum Technologists and their Application Forms may be seen at the Offices of the Institution :—

As Members :—	Proposed By	Seconded By
ATWATER, Arthur Clark, Chemical Engineer, c/o Arthur G. McKee & Co., 541, Bush House, Aldwych, London, W.C. 2 ..	V. Henny.	W. H. Jones.
BARTON, Cyril Henry, Chemist, Chemical Dept., Asiatic Petroleum Co., St. Helen's Court, Great St. Helens, London, E.C. 3	J. Kewley.	A. E. Dunstan.
CARTWRIGHT, Edward Rogers, Engineer, c/o Asiatic Petroleum Co. (S.S.), Ltd., Singapore ..	G. S. Joannides.	Peter Kerr.
COCHIUS, Frans M.G., Chemical Engineer, c/o Astra Romana, Ploesti, Rumania	J. E. Treacy.	Percy R. Clark.
ELSBY, Leslie Francis, Engineer, Shell Co. of New Zealand, Ltd., A.M.P. Buildings, Wellington, New Zealand	Thomas M. Hartigan.	J. Kewley.
GABRIEL, Leonard Gowen, Chief Chemist, Colas Products, Ltd., Buckingham Gate, London, S.W. 1	J. Kewley.	W. W. Goulston.
MATSELL, Albert, Chemist, c/o Anglo-American Oil Co., Ltd., Birkenhead	F. H. Garner.	Walter Woodrow.
STREDWICK, Thomas Albert George, Engineer, c/o Asiatic Petroleum Co. (S.S.), Ltd., Singapore	G. S. Joannides.	Peter Kerr.

	Proposed By	Seconded By
As Members contd. :—		
WILLIAMSON, Thomas Fulton, Geologist, c/o Iraq Petroleum Co., Ltd., King William Street House, Arthur Street, London, E.C. 4	F. R. S. Henson.	D. A. Greig.
As Transference to Member :—		
BARROW, Geoffrey, Geologist, 126, Oxford Road, Moseley, Birmingham	T. D. Ambrose.	E. J. Horley.
As Associate Members :—		
BOLTON, Cedric Michael Grey, Geologist, "Warmlake Pines," Sutton Valance, Kent	H. T. Mayo.	S. Lister James.
HEWITT, Albert Ernest, Engineer, c/o Rising Sun Petroleum Co., Ltd., Central P.O. Box 401, Yokohama, Japan	R. G. Strickland.	J. S. Jackson.
SHIPMAN, Edwin Malcolm, Engineer, c/o Shell-Mex, Ltd., Shell Corner, Kingsway, London, W.C. 2	J. Kewley.	J. S. S. Brame.
WOOD, Norman Edward, Chemist, c/o Shell-Mex, Ltd., Shell Corner, Kingsway, London, W.C. 2	J. S. Jackson.	A. M. E. Beavan.
As Transference to Associate Members :—		
BROADHURST, Ronald, Engineer, c/o Sarawak Oilfields, Ltd., Miri, Sarawak	A. W. Noble.	C. M. Pollock.
TESTER, Henry Ernest, Chemist, c/o Anglo-Persian Oil Co., Ltd., "Meadhurst," Sunbury-on-Thames, Middlesex	F. B. Thole.	S. Bowman.
As Students :—		
BAILEY, Bertrand Dexter, Student, The University, Edgbaston, Birmingham	Alfred W. Nash.	A. R. Bowen.
BURGESS, Douglas Weston, Student, The University, Edgbaston, Birmingham	Alfred W. Nash.	A. R. Bowen.
KEACH, Raymond Harry, Student, The University, Edgbaston, Birmingham	Alfred W. Nash.	A. R. Bowen.
LINTON, Patrick Beverley Maples, Student, Imperial College Union, South Kensington, London, S.W. 7	V. C. Illing.	
MAYO, Frank, Student, The University, Edgbaston, Birmingham	Alfred W. Nash.	A. R. Bowen.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

ANNUAL REPORT OF THE COUNCIL, 1930-31.

THE Accounts for the year ended December 31st, 1930, together with the Annual Report of the Council for the Session, 1930-31, are hereby submitted.

The following table shows the changes in Membership during the year 1930 and the total Membership at December 31st, from which it will be seen that the Membership continues to increase.

	TOTAL 31.12.29.	CHANGES DURING 1930							TOTAL 31.12.30.
		New.	Transferred to.	Resigned.	Deceased.	Removed.	Transferred from.	+ —	
Honorary Members...	15	—	—	—	1	—	—	— 1	14
Members	537	28	8	14	4	8	—	+10	547
Associate Members ...	424	37	15	4	2	4	8	+34	458
Students	119	36	—	4	—	7	13	+12	131
Associates.....	81	13	1	3	—	2	3	+ 6	87
TOTALS	1176	114	24	25	7	21	24	+61	1237

The Council regret to have to announce the death of the following Members :—

Sir Richard W. Barnett, Sir Frederick W. Black, Sir Aston Cooper-Key, J. Bryson, G. Johnston, J. E. Nicholls and R. S. Wishart.

The Accounts for the year ending December 31st, 1930, are presented. The Council regard the position shown as satisfactory having regard to the larger expense in connection with the Journal and its issue in nine parts instead of six as formerly.

The Scholarships awarded by the Institution have been provided for in the Accounts and it has been decided to continue the Awards for the year 1931.

The Standardization Committee has continued its work during the year under review, and has been consulted by official and other bodies. The demand for the book on "Standard Methods of Testing Petroleum and Its Products" has continued to be satisfactory.

The Institution is represented on the following :—British Engineering Standards Association, the American Society for Testing Materials, the Advisory Board of the Department of Oil Engineering and Refining of the University of Birmingham, the

British Association for the Advancement of Science, the Fuel Economy Committee, the Imperial Mineral Resources Bureau, the British Committee of the World Power Conference and the Mechanical Warfare Board of the War Office.

Official Delegates attended on behalf of the Institution the following :—The 10th Congrés de Chimie Industrielle (Liège), the International Road Congress (Washington), the International Petroleum Exposition (Tulsa), the Jubilee of the Mason Science College, Birmingham, and the 30th Anniversary of the Granting of a Royal Charter to Birmingham University, at which a Complimentary Address from the Institution was presented.

Eight General Meetings of the Institution were held during the year 1930, at which the following papers were read and discussed :—

One Hundred and Twenty-fourth General Meeting, January 14: "Efficiency in the Distillation of Light Oils from Crude Oil," by A. A. Ashworth.

One Hundred and Twenty-fifth General Meeting, February 11: "The Oilfields of Alberta," by E. H. Cunningham Craig.

Seventeenth Annual General Meeting, March 20: Presidential Address, "The Chemist in the Petroleum Industry," by A. E. Dunstan.

One Hundred and Twenty-sixth General Meeting, April 8: "Some Features of Modern Steam Operated Deep Hole Rotary Drilling Plant," by Niels Matheson.

One Hundred and Twenty-seventh General Meeting, May 13: "Oil Well Deviation," by D. P. Rees.

One Hundred and Twenty-eighth General Meeting, October 14: "Experiments to Determine Velocities of Flame Propagation in a Side Valve Petrol Engine," by H. S. Glyde.

One Hundred and Twenty-ninth General Meeting, November 11: "Synthetic Lubricating Oils," by A. W. Nash.

One Hundred and Thirtieth General Meeting, December 9: "Gas in Relation to Oil Production," by B. J. Ellis.

The Meetings continue to be held at the House of the Royal Society of Arts, John Street, Adelphi, London, W.C. 2, and the Council beg to tender their thanks to that Society for their courtesy.

Volume XVI. of the Journal was published in nine parts, and the Council have decided that, in future, the Journal shall be published in twelve monthly parts per annual volume. A special Sub-Committee was appointed to consider the Abstracts, and it is anticipated that their recommendations will add considerably to the value of this section of the Journal.

The Students' Sections at London and Birmingham report the regular holding of Meetings and reading of papers. A small Committee of Council has been appointed to advise and assist the

Students' Sections, and the Council have made a grant of £10 for the year 1931, to be administered by this Committee, to assist Student authors of papers to be read before the Section in the preparation of diagrams and slides, etc.

Six papers were submitted for the Students' Medal and Prize for the 1929-30 Session. The Medal and Prize was awarded to Mr. L. C. Stevens, of Birmingham University, for his paper on "Methods of Increasing the Yield of Oilsands, with Special Reference to Repressuring." A Special Prize was awarded to Mr. P. N. D. Porter, of Birmingham University, for his paper on "Field Application of Electricity"; and Mr. A. P. Chamberlain, of Birmingham University, was commended for his paper on "Mechanical Design in Relation to Detonation."

The Institution's Scholarships for 1930-31 were awarded to Mr. G. Richardson, at the Royal School of Mines, London, and Mr. T. G. Robson, at Birmingham University.

The Institution's Research Fellowship has been awarded to Dr. H. R. Lang for a second year to continue his Research Work at the Imperial College of Science and Technology, London, on Specific Heats.

Mr. James Kewley, M.A., F.I.C., F.C.S., M.I.Chem.E., has been unanimously elected President for the Session 1931-32. The following Vice-Presidents, Sir John Cargill, Mr. A. E. Chambers, Mr. Alexander Duckham, Mr. Arthur W. Eastlake and Mr. Robert Redwood, have been unanimously re-elected, and Mr. T. Dewhurst and Mr. A. Beeby Thompson have been unanimously elected as Vice-Presidents for the ensuing year.

The Council regret to announce that a Notice has been received from His Majesty's Privy Council, stating that they were unable to recommend to His Majesty the King that a Royal Charter should be granted to the Institution.

The Reports from the Branches of the Institution in Persia, Roumania, South Wales and Trinidad continue to show satisfactory progress.

Members, British and other Government Departments, and industrial organisations in this and foreign countries have made increased use of the Library as a ready and reliable source of information.

The Council again desire to call attention to the Benevolent Fund, and it is hoped that Members will subscribe generously and regularly to the Fund. By the will of the late Sir Richard Barnett, a former Vice-President, the sum of £1,000 was bequeathed on reversion to this Fund. For the convenience of those Members who desire to make an annual subscription a Banker's Order may be obtained from the Secretary of the Institution.

Dr. REVENUE ACCOUNT FOR THE

	£	s.	d.
To Salaries	1049	3	5
„ Rent, Rates, etc.	445	0	10
„ Printing and Stationery	193	18	4
„ Postage	247	8	0
„ Expenses of Meetings, Including Hire of Hall	198	8	11
„ Journals and Publications (Net Expense)	836	2	2
„ Grants to Branches	123	0	0
„ Sundry Expenses	295	2	0
„ Auditors' Fee	10	10	0
„ Students' Prize and Scholarship Fund	80	0	0
„ Depreciation of Office and Library Furniture and Library Books	47	11	7
„ Students' Section	17	8	2
	£3543	13	5

STUDENTS' PRIZE AND

1930.	£	s.	d.	£	s.	d.
Dec. 31. To Scholarships Granted—						
Imperial College of Science and Technology ..	40	0	0			
Birmingham University	40	0	0			
Special Prize	5	0	0			
				85	0	0
„ Balance Carried Forward				5	0	0
				£90	0	0

RESEARCH

1930.	£	s.	d.
Dec. 31. To Fellowship and College Fees	336	2	6
„ Balance Carried Forward	739	7	3
	£1075	9	9

YEAR ENDED 31ST DECEMBER, 1930. Cr.

	£ s. d.	£ s. d.
By SUBSCRIPTIONS—		
Members	3015 12 0	
Special	20 0 0	
		3035 12 0
„ INTEREST AND DIVIDENDS LESS TAX		168 17 7
„ BALANCE, BEING DEFICIT FOR THE YEAR CARRIED TO BALANCE SHEET		339 3 10
		£3543 13 5

SCHOLARSHIP FUND.

1930.		£ s. d.
Jan. 1.	By BALANCE BROUGHT FORWARD	10 0 0
Dec. 31.	„ REVENUE ACCOUNT	80 0 0
		£90 0 0

FUND.

1930.		£ s. d
Jan. 1.	By BALANCE BROUGHT FORWARD	1054 3 8
Dec. 31.	„ INTEREST AND DIVIDENDS LESS TAX	21 6 1
		£1075 9 9

BALANCE SHEET AS

	£ s. d.	£ s. d.	£ s. d.
CAPITAL OF THE INSTITUTION, under By-Law Section 6, paras. 14 and 15 :—			
Life Membership Fund—			
As at 31st December, 1929	498 10 0		
Additions during year	20 10 0		
		519 0 0	
Entrance Fees—			
As at 31st December, 1929	1823 15 0		
Additions during year	133 8 0		
		1957 3 0	
Profit on Sale of Investments—			
As at 31st December, 1928		2 10 0	
Donations—			
As at 31st December, 1928		326 5 0	
			2804 18 0
STUDENTS' PRIZE AND SCHOLARSHIP FUND..			5 0 0
RESEARCH FUND			739 7 3
MEMBERS' SUBSCRIPTIONS PAID IN ADVANCE			127 14 0
JOURNAL SUBSCRIPTIONS PAID IN ADVANCE			382 10 1
SUNDRY CREDITORS			346 19 2
REVENUE ACCOUNT :—			
Balance as at 31st December, 1929 ..		1615 13 11	
Add : Subscriptions previously written off and now collected		38 17 0	
		1654 10 11	
Less : Deficit for year as per separate account		339 3 10	
			1315 7 1
			£5721 15 7

Members of Council { ARTHUR W. EASTLAKE. ROBERT REDWOOD.

AUDITORS'

To the Members of
THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

We have examined the above Balance Sheet with the books of the Institution are of opinion that such Balance Sheet is properly drawn up so as to exhibit a true our information and the explanations given to us and as shown by the books of

3, FREDERICK'S PLACE,
OLD JEWRY, LONDON, E.C. 2.
2nd February, 1931.

AT 31ST DECEMBER, 1930.

	£ s. d.	£ s. d.
INVESTMENTS AT COST :—		
On Account of Capital—		
£1250 0 0 5% War Loan 1929/47	1196 18 6	
650 0 0 3½% Conversion Loan	505 7 0	
664 6 6 London County 3% Consolidated Stock	481 10 6	
150 0 0 Birmingham Corporation 6% Stock 1936/46	146 16 0	
100 0 0 Wigan Corporation 5% Redeemable Stock	99 14 11	
160 0 0 New South Wales 5% Stock 1945/65..	158 7 0	
100 0 0 5% Conversion Stock 1944/64 ..	102 3 6	
		2690 17 5
(Market Value at 31st December, 1930, £2760 0s. 4d.)		
On Account of Revenue—		
£800 0 0 5% War Loan 1929/47		810 15 9
(Market Value at 31st December, 1930, £824)		
On Account of Research Fund—		
£500 0 0 5% War Loan 1929/47		510 8 3
(Market Value at 31st December, 1930, £515)		
OFFICE AND LIBRARY FURNITURE (excluding Presentations) :—		
As at 31st December, 1929	428 12 7	
Additions during year	35 9 0	
	464 1 7	
Less: Depreciation	21 8 7	
		442 13 0
LIBRARY BOOKS (excluding Presentations) :—		
As at 31st December, 1929	174 5 8	
Additions during year	11 17 8	
	186 3 4	
Less: Depreciation	26 3 0	
		160 0 4
MEMBERS' SUBSCRIPTIONS OUTSTANDING CONSIDERED COLLECTIBLE		172 14 6
SUNDRY DEBTORS AND PAYMENTS IN ADVANCE ..		117 15 9
CASH ON DEPOSIT WITH BANKS :—		
Research Fund	224 15 9	
General Account	200 0 0	
		424 15 9
CASH AT BANK AND IN HAND		391 14 10
		£5721 15 7

REPORT.

and have obtained all the information and explanations we have required. We and correct view of the state of the Institution's affairs according to the best of the Institution,

PRICE, WATERHOUSE & CO.

The Twelfth Annual Dinner was held at the Connaught Rooms, Great Queen Street, London, on December 10th, 1930, and was attended by over 200 Members and Guests.

The Council have approved the following alteration to the By-Laws :—

Section III. Para. 4.—Delete the words "of a character recognised as leading up to qualification for Membership."

Section VII. Para. 2.—Delete "four" and insert *five.*

Para. 5.—Delete "31st day of January" and insert *30th day of November.*

The Council beg to tender their thanks to the following for their services rendered to the Institution :—

Lord Plender, G.B.E., Honorary Treasurer; Messrs. Ashurst, Morris, Crisp and Co., Honorary Solicitors; Messrs. Price, Waterhouse and Co., Auditors; and the Editorial, Library and Office Staffs.

The Auditors retire and, being eligible, offer themselves for re-election.

By Order of the Council,

ARTHUR W. EASTLAKE,
Honorary Secretary.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

BENEVOLENT FUND.

FROM INCEPTION, JUNE 17TH, 1929, TO DECEMBER 31ST, 1930.

	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Donations	218 11 0		Expenses (Cheque book) ..	8 4	
Subscriptions	9 4 6		Grant in Aid	26 5 0	
		227 15 6	Loan	15 0 0	
Interest on Deposit Account		3 0 9			41 13 4
			Balance at Bank on Current and Deposit Account, 31st December, 1930		189 2 11
		£230 16 3			£230 16 3

We have examined the above Account with the books and vouchers of the Fund and find the same to be correct.

3, Frederick's Place,
Old Jewry,
London, E.C. 2.
4th February, 1931.

PRICE, WATERHOUSE & CO.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

EIGHTEENTH ANNUAL GENERAL MEETING.

THE EIGHTEENTH ANNUAL GENERAL MEETING of the Members of the Institution of Petroleum Technologists was held at the House of the Royal Society of Arts, John Street, London, on Tuesday, March 31st, 1931, the Chair being taken by the President, Dr. A. E. Dunstan.

The Secretary read the notice convening the meeting and the Auditors' certificate, after which the Minutes of the last Annual General Meeting were read and confirmed.

The list of Members elected and transferred during 1930 was laid on the table.

The list of members elected since the last General Meeting was read, as follows :—

Members.—Enoch Hotham, Elliot David Lindop.

Associate Members.—Walter Allison Keightley, Terence Blair Rendel.

Student.—William James Baker.

Associates.—William Ernest Bruges, Henry Oswald Clayton, Norman Ellathorne Jones, Hubert William Henry Lee.

The list of Members nominated for election since the last General Meeting was also read.

ANNUAL REPORT OF COUNCIL FOR 1930.

The President, in proposing the adoption of the Annual Report, referred to the great loss which the Institution had suffered in the deaths of Sir Richard Barnett and Sir Frederick Black, two Members of Council of long-standing, whose wisdom, knowledge and reputation had been of the greatest possible service to the Institution both in its younger days, when it had been a very small concern, and lately when it had become a power in the land of petroleum technology.

There were one or two matters in the Report to which he would refer. In the first instance, there was the Journal. This year the members were seeing the great experiment made of a monthly Journal. The Journal was published once a quarter when Sir Boverton Redwood had given him the task ten years ago of watching over its fortunes. Previously they had published eight papers a year and nothing more. To-day the Members had a Journal which ranked extremely high in the technical and scientific world

not only because of the wealth of knowledge disseminated in the very important papers, both communicated and read, but also in the Abstract Section—which, he was happy to say, was second to none. He desired, in referring to the Journal, to express his own personal thanks to Mr. George Sell, who had been the right-hand man of the honorary editor for the last eight years, and to Mr. W. H. Thomas who had taken over the very arduous work of putting the abstracts in a proper form, making them an extraordinarily effective summary of the work carried out throughout the whole world both in petroleum and all its cognate subjects. (Applause.)

He desired also to refer again in very brief terms to the Benevolent Fund. It was a matter which personally to him was a very dear project. It had been instituted in his own term of office. It had benefited recently by the extremely kindly and characteristic bequest of the late Sir Richard Barnett. Although at the present time he was thankful to say no serious claim had been made upon the Fund, at the same time the occasion would inevitably arise when it would be wanted, and he would urge all members to set aside some small sum and send it along with their annual subscription. They should look upon their annual subscription as not well paid unless accompanied by some reasonable attempt to strengthen this very useful Fund.

Last year reference had been made to the building scheme in which the Institution was interested along with many other corresponding societies. It was unnecessary to refer to the evil times through which the country was passing, or to the great difficulty of raising funds for any purpose no matter how good; at the same time there had been got together, with some difficulty admittedly, a very considerable sum, and although the building scheme at the present moment might be said to be somewhat of a dormant scheme, that period of hibernation was only a transitory period and he hoped with his own eyes to see a great building erected, holding in it their own and all the other great cognate scientific and technical societies, with one great library and with meeting rooms which would be in all respects worthy of British technical science.

The Institution had been disappointed during the last year in the failure of its efforts to obtain a Royal Charter. He would again say to the Members that that failure was again a transitory and temporary failure. The membership was rising in such a steady way as inevitably to justify the accordance to the Institution of that measure of dignity which it deserved.

In the current year the Institution had been faced with difficulties financially. When bad times came one's subscription to a scientific or technical society was the first thing to lapse. In common with

all societies that had happened to the Institution. In this period of slump and depression, rigid economy was essential in the administration of all societies, private or public, and he could assure the Members that their Council was watching the situation with extreme care.

Mr. Kewley seconded the motion that the Report of the Council for 1930 be adopted, and it was carried unanimously.

ALTERATION OF BY-LAWS.

The President announced that certain alterations in the By-laws had been put forward by the Council after careful consideration by a Special Committee appointed for that purpose, and he called upon the Secretary to read the alterations suggested.

The Secretary said that the first alteration was in regard to Section III., para. 4, from which it was proposed to delete the words "of a character recognised as leading up to qualification for Membership."

The President remarked that the reading of the original By-law implied that the qualification of an Associate Member was such as would reasonably bring him ultimately into the category of a Member. It was felt, after some years experience, that it was by no means necessary or essential, no matter how desirable, that that qualification should stand.

Sir Thomas H. Holland seconded the motion, which was carried unanimously.

The Secretary said that the next alteration was in regard to Section VII., para. 2, and it was suggested that the word "four" be changed to "five" in both places.

The President said that the reason for the proposed amendment was that, with the growing membership of the Institution, the Council had increased its number, and in order to get a pro rata change in resignation each year, five members in place of four would retire.

Sir Thomas H. Holland seconded the motion, which was carried unanimously.

The Secretary stated that the next alteration referred to Section VII., para. 5, in which it was proposed to insert the words "30th day of November" in place of "31st day of January."

The President explained that at present members residing outside the United Kingdom did not have time to return their Council Voting papers by the date of the opening of the ballot. The proposed change would enable overseas members to exercise their right of franchise.

Sir Thomas H. Holland seconded the motion and it was carried unanimously.

BALANCE SHEET AND ACCOUNTS.

The President formally proposed the adoption of the Balance Sheet and asked Mr. Alfred C. Adams to give, as on many previous occasions, his excellent account of the financial standing of the Institution.

Mr. A. C. Adams said that as the President had remarked it had been his privilege for a good many years past, as Chairman of the Finance Committee, to support the President's motion for the adoption of the accounts. Therefore it was unavoidable to inflict upon the members a little repetition.

Going briefly through the balance sheet, he pointed out that the capital of the Institution, which consisted of the accumulation of life membership fees, entrance fees and donations, had been last year increased by a number of entrance fees of new members amounting to £153 18s. This capital item, which now amounted to £2,804 18s., corresponded with the investment item on the other side of the balance sheet; but the amount shown as invested was rather less than the amount of the capital. That was due to the accumulation of entrance fees in the course of the year being deposited with the bank instead of being invested, until it had reached a reasonable sum; but the amount had been invested in a more permanent way now, so that the investment figure and the capital item at present coincided as nearly as they ever would.

The Students' Prize and Scholarship Fund represented the amount in hand for that purpose, and similarly the next item was the amount in hand for research, particulars of which were shown in the separate accounts. The whereabouts of the money could be seen on the other side of the balance sheet in the sums invested and on deposit in that account. Members' subscriptions and Journal subscriptions paid in advance were sums which did not belong to 1930, and were carried forward to the present year.

Sundry creditors represented the ordinary outstanding accounts unpaid at the period of balancing, and which had since been cleared off.

On the other side would be seen the investments already referred to—an amount also invested on account of revenue of £810 15s. 9d., as well as the sum invested on account of research work.

Office and library furniture was much the same figure as in 1929, and this had been depreciated according to the usual scale adopted. The same might be said of the library books, which stood at rather less than in 1929. Members' subscriptions

outstanding amounted to £172 14s. 6d. That sum actually represented 50 per cent. of the amount of subscriptions remaining unpaid during 1930. Experience in previous years had shown that over 50 per cent. of unpaid subscriptions, which had been written off as unlikely to be received, had been recovered. Therefore in consultation with the auditors credit had been taken for 50 per cent. of unpaid subscriptions. Experience had shown that many such subscriptions which had been written off frequently came in two, three or even four years afterwards. There was evidence of that in the balance sheet, because an amount of £38 17s. had been recovered, although written off in a previous year.

Sundry debtors and payments in advance represented monies owing to the Institution, but unpaid at the time of balancing. Cash on deposit at the bank amounted to £424 15s., and there was cash at the bank and in hand of £391 14s. 10d., the result showing a balance to the credit of revenue account of £1,315 7s. 1d.

Turning to the revenue account, there was little need for comment, except perhaps in two particulars. The amount received from subscriptions, the members would see if they compared it with 1929, was not very much more than in the former year. He had already stated that there was a considerable figure in the shape of subscriptions in arrear unpaid which amounted to nearly £350. This was somewhat a new feature to the Institution, and, as the President had said, it was probably due to the acute depression, which affected individuals just as much as industry. It was a position which the Council was watching, and would continue to watch.

The other item to which he would refer was that of the Journal. The net cost of the Journal and publications in 1930 had been £836 as against £379 in 1929. That was a difference of £457. That increased expense was attributable to the extra cost of producing and issuing the Journal in nine parts instead of in six parts as before.

If the members considered those two points—the temporary lack of subscriptions coming in, and the cost of the Journal—he thought they would agree that the year's working of the Institution showed up very satisfactorily, seeing that it only showed an adverse balance of £339. The Journal was now being issued in 12 monthly parts, and it was anticipated that the cost of issuing those 12 parts would enable the Finance Committee to show a great improvement on the item which appeared in the accounts for the year's cost of the Journal.

He formally seconded the motion for the adoption of the accounts.

The President, after enquiring if any member desired to ask Mr. Adams any question, formally put the motion to the meeting, coupling with it a very sincere vote of thanks to Mr. Adams. It had been his (the President's) good fortune on various occasions to have served on the Finance Committee of the Institution, and he could assure the Institution and the members how indebted they were to Mr. Adams for the great care which he took in this most important part of their work. Without a good sound financial management no institution could prosper. The Institution had that sound management in Mr. Adams.

The motion was put and carried with acclamation.

STUDENTS' SECTION.

The following Reports from the London and Birmingham Branches of the Students' Section were laid on the table :—

London Branch.—On December 31, 1930, the Student Members of the Institution numbered 131. During the year under review there were, in the London Area, 14 new members, to whom a hearty welcome is extended : two members were transferred, one removed and two resigned.

At the Seventh Annual General Meeting held in February, 1930, the following were elected to serve on the Committee : Messrs. J. E. Duckham, G. Paice, R. C. Simmonds, C. E. Hobley, G. Richardson and P. A. Spens. Mr. Duckham was subsequently elected Chairman ; Mr. Simmonds, Hon. Excursion Secretary ; and Mr. Spens, Hon. Secretary.

During 1930 seven meetings were held :—

January.—" Pinking," by N. Wood.

February.—" Production Methods in Rumania," by G. Richardson.

March.—" The Geology of Some Rumanian Oil-Fields," by C. E. Hobley.

May.—" The Origin of Petroleum," by J. J. G. Clark.

October.—" Rotary Drilling Methods in Rumania," by P. M. Falconer.

November.—" Equipment Used in Deep Well Drilling," by R. E. James.

December.—" The Opening-up of an Oil-Field Concession," by Prof. V. C. Illing.

Two excursions were held in 1930 ; in February, to the Fairey Aviation Company's Works, Hayes, Middlesex, and in November, to the Gas Light and Coke Company's Works, Richmond.

The attendance at these excursions was quite good, although there is still plenty of room for improvement in this direction. The Committee, however, realise the impossibility in arranging a time suitable for all members.

Owing to the extremely bad attendance at the meetings last year, a Committee Meeting was held before the beginning of the Session to discuss any means with respect to its improvement. It was finally decided, in view of the impossibility of getting into touch personally with the members, and in view also of the negative results of correspondence, to appeal to the Council for assistance. A letter was accordingly drafted and laid before the Council.

As a result of this letter, a Sub-committee of Council, comprising the President, Messrs. A. Duckham, Ashley Carter, T. Dewhurst, and Prof. Illing, was appointed to meet the Chairman and Hon. Secretary of the Students' Section. Two meetings were held.

The outcome of these meetings, after the approval of Council, may be translated as follows :—

(1) A Sub-committee of Council, consisting of the President, Mr. Ashley Carter, Mr. Arthur W. Eastlake, Prof. V. C. Illing, Dr. F. B. Thole and Mr. A. Beeby Thompson, has been appointed to assist the Students. In addition to this, Mr. Ashley Carter has very kindly consented to act as an intermediary between the Students and the Sub-committee.

(2) An annual grant of £10 has been approved to assist the Students in their preparations for papers.

(3) It was decided that the space allotted to the Students' Meetings on the General Meeting Cards should be more prominent, and that a notification to the effect that all classes of members were welcome, be included.

(4) It has been decided that Aldine House should remain the centre of the meetings, but that the time be altered to 6 o'clock.

(5) It has also been decided that a *précis* of the papers should be inserted each month in the Journal.

As a result of this generous help on the part of the Council, the attendance at the last few meetings has been considerably improved. This is, however, largely due to the attendance at these meetings of other classes of members.

The Council have awarded the Scholarship at the Royal School of Mines to Mr. G. Richardson.

Three papers were entered for the Students' Medal and Prize from the London Area. The Medal and Prize, however, were awarded to Mr. L. C. Stevens, B.Sc., of Birmingham. We should like to see more papers from the London Section entered for this prize. Papers need not necessarily have been read before the Section.

The Committee wishes to thank the senior members of the Institution who have attended the meetings, and aided the Section both with papers and in the discussions. In particular would they like to thank those members of Council who are acting as advisers to the Section on the Sub-committee appointed for the purpose, and also Mr. Ashley Carter, for kindly acting as sponsor.

(Signed) P. A. Spens, Hon. Secretary.
(Countersigned) A. E. Dunstan, President.

Birmingham Branch.—The Committee has pleasure in presenting the Eighth Annual Report, for the year ended December 31, 1930.

At the Annual General Meeting the following officers for this branch were elected: Mr. M. J. Mehler (Chairman), Mr. A. J. Swann (Vice-chairman), Dr. A. R. Bowen (Hon. Secretary and Treasurer), Messrs. F. K. Naficy, N. M. Johnson, H. C. H. Darley and E. E. Thornelo (Committee).

The Birmingham Branch was fortunate in obtaining the Students' Medal and Prize, which was awarded to Mr. L. C. Stevens for his paper on "The Re-pressuring of Oil Sands," and the Special Prize, which was obtained by Mr. P. N. D. Porter for his paper entitled "Field Applications of Electricity." Honourable mention was made of the paper by Mr. A. P. Chamberlain on "Mechanical Design in Relation to Detonation."

During the year six meetings were held and attendances at these were consistently good.

The following meetings were held and papers read :—

January 21.—"The Re-pressuring of Oil Sands," by L. C. Stevens.
February 11.—"Column Fractionation," by G. W. Ford.
March 4.—Annual General Meeting.
May 6.—"Low-Temperature Carbonisation," by Lt.-Col. S. J. M. Auld.
October 28.—"Adsorption," by A. J. Swann.
November 18.—"Oilfield Waters," by T. G. Robson.

On February 28, 1930, the members of the branch paid a visit to Messrs. Latch & Batchelor's Wire Rope Works, Hay Mills, Birmingham, and on December 6 inspected a Gardner oil-engined motor omnibus belonging to the County Borough of Walsall Tramway and Motor Services, kindly arranged by Mr. W. Vane Morland.

(Signed) A. R. BOWEN, Hon. Secretary.

(Countersigned) A. E. DUNSTAN, President.

RE-ELECTION OF AUDITORS.

On the motion of Mr. L. P. Timmins, seconded by Mr. W. H. Thomas, Messrs. Price, Waterhouse & Co., were re-elected auditors for the ensuing year.

ELECTION OF COUNCIL.

The Secretary announced that eleven Members were nominated to fill nine vacancies on the Council and as a result of the ballot Mr. Ashley Carter, Mr. G. H. Coxon, Mr. C. Dalley, Mr. B. J. Ellis, Professor V. C. Illing, Mr. J. S. Jackson, Mr. J. McConnell Sanders and Dr. A. Wade had been re-elected and Mr. John Gillespie had been elected.

This concluded the formal business of the meeting.

INDUCTION OF NEW PRESIDENT.

The President said it was with very peculiar pleasure that he introduced to the Members their new President, Mr. James Kewley. It had been his good fortune now for many years to have enjoyed Mr. Kewley's friendship, and he thought he might venture to say that Mr. Kewley and himself on a variety of occasons had done some real good in breaking down the artificial barriers which had stood between profession and profession and sometimes even between company and company. Mr. Kewley was very well known to the Institution. He had served for many long years on the Council and on the multifarious committees of the Council, and had done yeoman service, in particular, with the Standardization Committee and its recent development in connection with the attempt to get international standardisation of the so-called engine test or detonation test for motor fuels. Mr. Kewley had published valuable articles in the Transactions, and from every point of view, professional and otherwise, one could not imagine a more ideal choice of the Council for President. Not only was Mr. Kewley well known in the Institution, but he was well known wherever petroleum was known. Incidentally, it might perhaps interest the members to realise how far flung the Institution was. He had in his hand a list which showed the circulation of the Journal. In Great Britain, for example, 738 copies were circulated ; in Asia 247 ; in Europe 216 in the U.S.A. 209 ; in South America 78 ; in the West Indies 46 ;

in Africa 33; in Central America 23; in Australasia 21; and in Canada 20. Wherever the Journal went, Mr, Kewley's name was known. He felt very confident that in Mr. Kewley's hands the Institution would go from strength to strength, and it was with the greatest pleasure that he inducted Mr. Kewley into the Presidential Chair.

Mr. James Kewley then took the Presidential Chair amid the hearty applause of the members.

The President (Mr. J. Kewley) said that he was proud to be one of the Original Members of the Institution, and he wished to express his very great appreciation of the honour and to thank the Council—the members' chosen representatives—for having conferred it upon him, and to give his assurances that, to the best of his ability, he would carry out the responsibilities which the position entailed and the opportunities which it offered. He would also like to thank Dr. Dunstan personally for the kind remarks he had made about himself, and he hoped that the results of his occupation of the Chair would give Dr. Dunstan some ground for thinking that his remarks were perhaps not altogether unfounded.

The responsibilities of such a position as he now occupied became greater every successive year, particularly so in the case of a young institution such as theirs—so young, indeed, that he personally could remember the days when in Borneo in 1907 they used to burn their surplus gasoline under stills and boilers in order to get rid of it.

He should describe the Institution as a very virile child of a virile parent, which was rapidly and steadily developing and assuming importance and position which were its due. It was true that the industry in general was suffering from the effects of the prevailing depression, but they were a technical Institution primarily, and technically he should say that the petroleum industry was far from suffering from depression, but was indeed flourishing. It had been stated recently that one of the causes of the depression was due to the over-activity of the petroleum technologists who had so developed the art of deep drilling that they had rendered available vast supplies of crude oil which, a decade or so ago, were not known to be extant, and so were not taken into consideration in the estimation of future supplies. Petroleum technologists were taking full advantage of the numerous new developments in technique of the various applied sciences of geology, chemistry, physics, and the many branches of engineering, such as methods of geophysical exploration, high temperature and high-pressure reactions, hydrogenation processes and the applications of metallurgy and electricity. A new phase—that of the production of chemical products from the hydrocarbons of natural and cracked gases, so long allowed to run to waste, was now coming into the picture.

With all these developments, the Institution must keep in close touch and endeavour to promote by encouraging research and by disseminating knowledge by means of the Journal.

There was one development, however, in which, on account of its special international nature, the Institution was particularly well fitted to take the lead. The Institution was truly an international society. He saw that the recent ballot lists had been sent out to members in no less than forty-five different countries, including such countries as British Guiana, Chili, Columbia, Costa Rica, Iraq, Malta, Sarawak and Venezuela. The development to which he referred was that to which Dr. Dunstan had alluded, namely, the standardising of testing methods. Individuals and representatives of companies could do much in the study of testing methods, particularly in the investigation and applicability and interpretation of such tests; but for their standardization and general adoption, co-operation was essential, and the arranging for such co-operation was the especial function of an institution such as the Institution of Petroleum Technologists. A good deal had already been done in this direction. The work of the Institution's Standardization Committee had met with general approval, and their methods were generally accepted by such an influential body as the British Engineering Standards Association. But very much more than that had recently happened. By a fortunate coincidence three members of the Council, Dr. Dunstan, Dr. Garner and himself, had happened to be in the United States last October, and had taken the opportunity of meeting one or two members of the American Society for Testing Materials, as the outcome of which they had been able to send a delegation of three Members—Messrs. Barton, Sprake and Stansfield—from this country to attend the meeting of the American Society of Automotive Engineers at Detroit, and had therefore established a definite contact in that direction which he hoped would be the nucleus of much greater things. He would say that this event was really a milestone on the road to the goal of international standardization, and led to the hope if not the expectation that the day when that might be realised was not perhaps so very far distant. The ardent pursuit of that goal was one of the duties of the President of the Institution.

It was now his very pleasant duty to propose a vote of thanks to the retiring President. It was a duty which was particularly pleasant to him. Their long acquaintance had enabled him to appreciate Dr. Dunstan's character, to admire his unbounded energy and to value his friendship. The Institution owed to Dr. Dunstan a great deal more than the thanks due to an energetic retiring President: it owed to him also thanks for an efficient editorship of the Journal. For more than half the life of the Journal Dr.

Dunstan had been its ruling spirit. (Applause.) The established reputation of the Journal was a monument to Dr. Dunstan's efforts. It was by the Journal that the world generally must judge them. In 1929 when Dr. Dunstan had been elected to the Presidential Chair and had been forced to give up, rather reluctantly no doubt, his active control of the Journal to their late friend Sir Frederick Black, he had stated that he would not be satisfied until it appeared monthly. Dr. Dunstan now had the satisfaction of seeing his hopes realised. At that time Dr. Dunstan had also expressed another wish. He had pointed to the good example set by Mr. Adams in taking up his duties as Chairman of the Finance Committee after he had retired from the Presidential Chair, and had hinted that he might feel inclined to do the same with regard to the Journal. This he had now agreed to do, for at least a year, and it was to be hoped that that period would be considerably extended. (Applause.) They might certainly rest assured that Dr. Dunstan would follow the good example set by their Past-Presidents and continue to take a very active interest in the work of the Council over which he had so ably presided for the last two years. He asked the members to join with him in according to Dr. Dunstan a very hearty vote of thanks for all he had done for the Institution, hoping that his interest in the future would not flag.

The motion was carried with acclamation.

Dr. A. E. Dunstan briefly acknowledged the vote.

The meeting then terminated.

Hydrated Lime and Diatomaceous Earth ("Diatomite") in Oil Well Cement.*

By Alexander Reid, M.A., B.Sc. (Student).

To produce a cement grout which can be easily handled by pumps, it is necessary to make the mix with a 40/50 per cent. water cement ratio. This large excess of water, above that required to provide proper hydration of the cement, reduces the ultimate strength of the cement on setting and hardening, and much more certain results might be had in oil well cementing if it were possible by any means to reduce the W/C ratio while maintaining the low viscosity required for pumping.

With this idea in mind, one of the major cement producing companies in this country was approached and the suggestion obtained that the addition of small quantities of either diatomaceous earth or hydrated lime to the cement mix should have the desired result. Experiments were accordingly carried out as soon as the necessary ingredients could be obtained, and this note is a record of the findings.

All tests were made using a standard brand of cement. Aged cement and fresh cement were both tested in the first series of experiments but later, tests in the second series were made using the fresh, good quality cement only.

Two grouts were employed, a 40 per cent. and a 50 per cent. gauge. Forty per cent. gauge is just a shade too "thick" for pumps to handle easily. If hydrated lime or diatomaceous earth had given reductions in viscosity, a 35 per cent. grout might have been possible but as far as the experiments go cement treated with lime would be best used as a 50 per cent./55 per cent. gauge grout.

Hydrated lime prepared in a variety of ways was used to see if any one special preparation conferred sensible benefits on the viscosity results. These methods are briefly outlined as follows:

(*a*) Quicklime of a high degree of purity was slaked and left to stand as a slurry for almost one month. The slurry was exposed to the atmosphere but protected from rain. The possibility of the formation of calcium carbonate by absorption of carbon dioxide from the air was neglected in this instance as the method of preparation is similar to that we should expect to apply to practice. After standing one month the slaked lime was carefully dried in an oven at 70°C. ground and sieved to 200 mesh.

(*b*) Lime was prepared as in (*a*) but the time of standing was shortened to (1) a fortnight (2) a week.

* Paper received November 24th, 1930.

(*c*) A sample of quicklime was ground to a fine powder in a mortar, the calculated quantity of carbonate—free water added in successive equal portions, and the mixture stirred with a pestle. When the calculated quantity of water had been added an additional 2 per cent. of water was added and the thick paste thoroughly stirred and after standing one day in a carbon-dioxide-free atmosphere, carefully dried, ground and sieved to 200 mesh. This lime was kept in a container free from carbon dioxide until required for experiments.

(*d*) A rather bigger sample of quicklime than in (*c*) was ground to 200 mesh and freshly boiled, carbonate free water was added drop by drop till slaking was complete. After a short time the slaked lime was converted to a slurry with carbonate-free water, and stored in a bottle free from carbon dioxide. After two days in this condition the sample was rapidly dried, ground and sieved and stored in a carbon dioxide-free atmosphere.

(*e*) To a sample of quicklime finely ground a big excess of pure water was added and the whole mixed thoroughly till the temperature of the mix returned to normal. A further excess of water was then added to make a fine slip which was allowed to stand one week before drying at 60°C./70°C.

In each of these methods the sample of hydrated lime can be considered to be perfectly hydrated. It was found that the differences in the results obtained for the various samples were not sufficient to commend any one method of preparation over the others.

Earlier experiments were performed with lime made by methods (*a*), (*b*) and (*c*). Methods (*d*) and (*e*) were used in later experiments.

The sample of "Diatomite" available was far too small for exhaustive tests, only leading experiments were possible. For these experiments the "Diatomite" was sieved to 200 mesh. It analysed as follows :—

	Per cent.
Loss on ignition	10·08
Silica CiO_4	83·68
Ferric oxide Fe_2O_3	2·62
Calcium oxide CaO	1·28
Magnesium oxide MgO	2·34
	100·00

Measurement of Viscosity.

The ability of a slush pump to handle a cement mix, other things being equal, will be a function of the viscosity of the mix.

It would be expected, therefore, that the methods used for measuring the viscosity of rotary muds might be applied to the measurement of the viscosity of cement grouts. To a limited

extent this is found to be possible, but the variation in size of the particles of the cement mix renders the orifice method of measuring viscosity uncertain. A concentric cylinder or paddle method might be employed, but tests made show that the settling of cement through the water in a mix is so rapid that results by this type of viscometer are difficult to reproduce.

For the same reason—rapid settling—the falling sphere method is found to be unreliable. The deformable sphere method, *i.e.*,

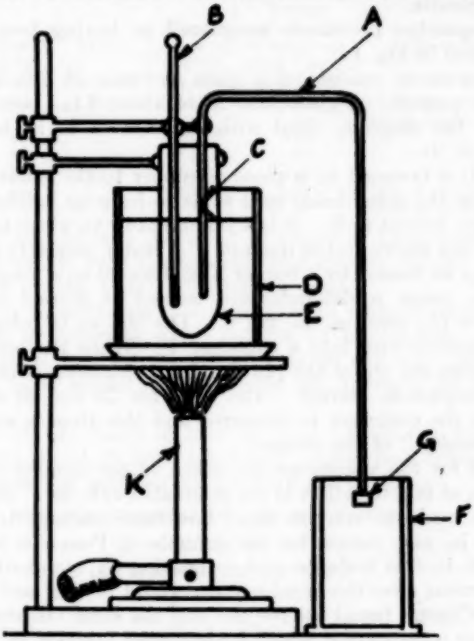


FIG. 1.

VISCOSITY APPARATUS FOR CEMENTS.

by measuring the rate of passage of gas bubbles through the mix, is promising, but difficult to perform with precision.

In the circumstances a form of viscosity measuring apparatus used in the ceramic industry for measuring the viscosity in clay slips was adopted, and it was found that results reproducible within 3 per cent. could be obtained. The apparatus is of the simplest and is commendable for that reason also. It cannot be

expected to yield highly accurate results, but the times recorded by the instrument are a very fair reflection of the actual kinematic viscosity of the mix.

In the early, and leading experiments, a funnel with a very wide mouth but long narrow spout was employed to give some indication of the viscosities and times to be expected. Results for this rough instrument were not always reliable and constant reduplications were resorted to in order to obtain consistent and uniform results.

The apparatus previously mentioned as having been adopted is illustrated in Fig. 1.

The apparatus consists of a glass test-tube E into which the cement is poured. A glass tube A, of about ¼ in. bore is fitted up as in the diagram, filled with the cement to be tested and clipped at G.

A pin C is fastened by a piece of rubber to the smaller limb of the U tube the point being bent so as to form an indicator of the level of the cement in E. B is a thermometer to which is attached a stirrer, not shown in the diagram. A water jacket D filled with water may be heated by a burner K and serves as a rough thermostat. To make a determination cement is poured into E to just above the level of the pin C. The clip at G being opened, cement syphons over into a container F. When the cement level in E reaches the tip of the pin C a fresh container is placed at F and a stopwatch started. The time for 25 c.c. of cement to collect in the container is measured and this time is recorded as the "viscosity" of the cement.

Results for the viscometer are taken as the number of seconds for 25 c.c. of mix to collect in the graduated cylinder. No attempt has been made to convert these flow-time readings to absolute viscosity in, say, poises, for the formula of Poiseuille is scarcely applicable in this instance and estimation by standardisation of the apparatus after the usual manner would be long and involved. Since the figures found are for one and the same viscometer, they are strictly comparative, which is their chief function in this work. The less the time for 25 c.c. of mix to collect in the cylinder obviously the more readily will the mix pump.

First Series of Experiments.

These were essentially rough and intended only to give an idea of the correct percentages of hydrated lime and "Diatomite" likely to be effective.

The procedure was as follows: (*a*) A cement mix of 40 per cent. gauge was made up and stirred for exactly 3 min. (It was found that the time of mixing had an appreciable effect on the

viscosity of the mix.) The time for 50 c.c. to pass through the funnel was then taken and a briquette made thereafter. Each briquette was allowed to stand for one day in moist air and then under the water for six days, at the end of which period its tensile strength was determined.

Table I. will illustrate results obtained for different portions of a cement sample. The grout used was 40 per cent. gauge.

TABLE I.

Index No.	Cement gauge.	Lime.	Time of flow of 50 c.c.	Tensile strength of briquette after 7 days.	Remarks.
	Per cent.	Per cent.	Seconds.	Lbs./sq.in.	
A.1	40	Nil.	238·4	462	Fairly average result for tensile stress.
A.2	40	,,	126·8	528	
A.3	40	,,	110·0	474	
A.4	40	,,	103·9	576	
A.5	40	,,	600·0	492	An abnormal result possibly due to wet cement

All these results were achieved at constant temperature, *viz.*, 85·5° F. There is very considerable variation in results possibly accentuated by the type of viscometer used.

In view of these results it was decided to make determinations in duplicate or triplicate where possible of all viscosity readings with the funnel form of viscometer. As 40 per cent. gauge had not yielded good results it was decided also to try a 50 per cent. gauge.

In Table II. the times of flow of 50 c.c. of cement containing various proportions of lime are noted. Lime and cement were ground and mixed previous to the addition of water.

The lime used was prepared by method (*c*) above.

TABLE II.

(*All determinations at* 89·8° *F.*)

Index No.	Cement gauge.	Lime.	Time of flow of 50 c.c.	Tensile strength after 7 days.	Remarks.
	Per cent.	Per cent.	Seconds.	Lbs./sq. in.	
B.1	50	Nil.	23·2	414	
B.2	50	0·2	26·2	347	
B.3	50	0·4	31·8	442	
B.4	50	0·6	31·2	420	Note slight decrease in viscosity.
B.5	50	0·8	30·8	260	Tensile strength abnormal.
B.8	50	1·0	30·4	324	
B.7	50	2·0	35·8	350	
B.6	50	5·0	51·6	384	

It will be noted that with small percentages of lime the time of flow of 50 c.c. increases—*i.e.*, the mix is less easily pumpable.

From 0·6 to 1 per cent. this increase is arrested, but the time of flow is never less than that for a no-lime mix. Above 1 per cent. a regular increase is again noted.

The experiments recorded in Table II. had been done with a sample of fresh and non-lumpy cement. Before proceeding to more accurate work it was thought desirable to have some figures for a lime admixture with aged cement. Such cement was "lumpy," and before mixing had to be partially reground. As Table III. will show, difficulty was had in obtaining reproducible results, but those found support those of Table II., in that addition of lime seems to increase the viscosity of a cement mix. It is also to be noticed that the tensile strengths obtained are on the average a little lower than those for good cement. Such a result is to be expected, but the difference was expected to have been rather more striking.

TABLE III.

(*Results at 85·5° F.*)

Index No.	Cement gauge. Per cent.	Lime. Per cent.	Time of flow of 50 c.c. Seconds.	Tensile strength after 7 days. Lbs./sq. in.	Remarks.
C.1	50	Nil.	24·8	Briquette broke under water.	Abnormal result.
C.2	50	0·2	33·8	308	
C.11	50	0·2	34·1	400	
C.10	50	0·4	40·7	360	
C.12	50	0·6	39·8	370	
C.9	50	0·8	43·6	380	
C.4	50	2·5	38·3	330	Reading presumed erroneous. Duplicates did not agree.
C.5	50	2·5	53·8	348	Results considered to be correct for 2·5% lime addition.
C.6	50	2·5	52·9	372	
C.3	50	5·0	37·2	334	Abnormal result.
C.7	50	5·0	65·7	404	Presumed correct readings for 5% lime addition.
C.8	50	5·0	67·6	400	
C.	50	Nil.	43·6	354	Grout mixed and flow time detd. at 10° C.

EFFECT OF "DIATOMITE" ON CEMENT GROUTS.

In view of these surprising results attention was focussed on "Diatomite." Small percentages were experimented with, using the rough viscometer.

Owing to the small quantity of "Diatomite" available only a few rough tests were made. Table IV. will illustrate these.

TABLE IV.

(*Results at* 85·5° *F.*)

Index No.	Cement gauge. Per cent.	"Diatomite." Per cent.	Time of flow of 50 c.c. Seconds.	Tensile strength after 7 days. Lbs./sq. in.	Remarks.
D.1	50	Nil.	31·6	340	Sample of cement exhausted. Test repeated below with different sample of cement.
D.2	50	0·2	32·6	342	
D.4	50	Nil.	37·8	Not recorded.	
D.5	50	0·2	38·4	,,	
D.6	50	0·4	40·8	,,	
D.7	50	0·6	47·2	,,	
D.3	50	0·2 trace of water-glass inadvertently added.	40·0	600	The very high tensile strength is remarkable.

The tests illustrate a sensible increase in viscosity of a cement grout on the addition of very small percentages of "Diatomite." That is, "Diatomite" makes the grout harder to pump. It is to be noticed that in D.3, where a trace of water-glass was inadvertently admixed in the grout, a high tensile strength was recorded. Whether this result is purely adventitious or not, it is not yet possible to say, but the result affords grounds for future experiment.

SECOND SERIES OF EXPERIMENTS.

The viscosity determinations in this series of experiments were made with the "U Tube" viscometer described, and are much more accurate and reliable than those in the first series. It will be noted, however, that the conclusions reached in the first series are strikingly verified in these results.

To obtain the best results for either hydrated lime or "Diatomite" it is necessary that the cement and lime or "Diatomite" should be as closely admixed as possible. For this reason it was decided to add the lime to the dry cement and then to mix these together

thoroughly before the addition of water. Results obtained and shown in Table V. were obtained for grouts mixed in this manner.

TABLE V.

Effect of (a) *Lime,* (b) "*Diatomite*" *and* (c) *Silica on the Viscosity of* 40% *Gauge Cement Grouts.*

Percentage of substance added.	Viscosity in seconds for Lime at 85° F.	"Diatomite" at 88° F.	Pure anhydrous silica at 84° F.
Nil.	120·3	124·2	120·3
0·2	132·0	129·8	134·8
0·4	134·4	143·6	153·4
0·6	133·0	150·4	163·2
0·8	149·5	202·8	178·7
1·0	154·5	226·7	202·5

It will be noted that :—

(*a*) There is a tendency for the increase in viscosity, due to lime additions, to be arrested at or round 0·6 per cent. This result confirms those of the first series of experiments.

(*b*) "Diatomite" "thickens" a cement mix much more rapidly than lime in the same proportion. It renders it more workable for structural purposes but less fitted for pumps to handle.

(*c*) The figures for pure silica (98 per cent. purity) are in rough agreement with those for "Diatomite" which is also almost pure silica. This lends colour to the theory that in a cement mix the increase of plasticity attributed to small percentages of "Diatomite" is due to the hydration of the silica and not to other substances present in "Diatomite."

The results just quoted are typical of a number of determinations with different cements and different methods of admixture. All point to the same conclusion—hydrated lime and "Diatomite" increase the viscosity of cement grouts. In the above experiments the cement contained no calcium chloride but subsequent experiments have shown that, if anything, hydrated lime and "Diatomite" have a more pronounced "thickening" effect on a grout containing calcium chloride.

EFFECT OF TEMPERATURE ON THE VISCOSITY OF A CEMENT GROUT.

This matter has not yet been thoroughly investigated, but a few determinations at 86° F. and 92° F. have been made using the rough funnel viscometer already described. It will be seen

from Table VI. that for a small rise in temperature the effect is to increase the viscosity by a very small amount :—

TABLE VI.

Lime. Per cent.	Time of flow for 50 c.c. at 86° F. Seconds.	92° F. Seconds.
Nil.	18·6	19·4
0·2	20·2	19·6
0·4	22·8	20·0
0·6	21·0	23·2
0·8	21·8	23·8
1·0	28·2	28·8

EFFECT OF TIME AND DEGREE OF MIXING ON THE VISCOSITY OF A CEMENT GROUT.

Quite early in the experimental work it was discovered that time of mixing had some effect on the viscosity reading. This matter has been partly investigated and it is found that mixing continuously up to ten minutes or thereby results in a gradual decrease in the viscosity as measured minute by minute but after this period there is a very steady and rapid increase till the mass becomes plastic. This result scarcely agrees with the work of K. E. Dorsch and A. Deubel (*Kolloid Zeitung*, 1930, 51, 180-186) who, using the immersion filter method, found that there was a sharp rise in viscosity during the first sixty minutes, then a region of constant viscosity for about thirty minutes, and finally a slow rise in viscosity. Perhaps the fact that these investigators worked on cement pastes of higher cement water ratio accounts for the difference.

Throughout the work covered by these notes, the viscosity was determined after three minutes in each case, this time being considered sufficient in the laboratory to give a good mixture. The few tests so far made indicate that, as far as lime is concerned, additional mixing up to ten minutes does not greatly alter the position—lime still increases the viscosity of the grout.

EFFECT OF LIME ON SETTING TIMES OF CEMENT GROUTS.

The effect of lime on the setting time of a 40 per cent. gauge cement at 85° F. has been found; repetition will be necessary to establish the results achieved. Table VII. gives results so far determined.

In these tests lime, prepared as in method (*a*) above was used. The cement had aged a little but appeared to be in good condition.

TABLE VII.

Lime added.	40% gauge with the addition of 3% calcium chloride.		40% gauge without the addition of calcium chloride.	
Per cent.	Initial set.	Final set.	Initial set.	Final set.
Nil.	2 hr. 22 min.	4 hr. 15 min.	3 hr. 24 min.	6 hr. 5 min.
0·2	2 „ 27 „	4 „ 23 „	3 „ 34 „	6 „ 11 „
0·4	2 „ 38 „	4 „ 39 „	3 „ 22 „	6 „ 17 „
0·6	2 „ 43 „	4 „ 33 „	3 „ 24 „	6 „ 8 „
0·8	2 „ 39 „	4 „ 44 „	3 „ 26 „	6 „ 23 „
1·0	2 „ 32 „	4 „ 37 „	3 „ 16 „	6 „ 6 „

All setting times were determined using the Vicat needle at a temperature as near to 85° F. as possible. From the results it seems that the setting times are not greatly affected by small quantities of lime, the general trend being apparently towards lengthening the time of the initial and final sets. We might conceivably extend our work to cover larger percentages of lime, but as 40–50 per cent. gauge mixes containing much more than 1 per cent. lime are unpumpable, there is little benefit to be derived.

The "Diatomite" sample was too small to permit of testing its effect on setting times.

EFFECT OF LIME ON THE TENSILE STRENGTH OF CEMENT.

Lime prepared as in method (*a*) was used in finding the effect of lime on tensile strength. Admixtures of lime up to 1 per cent. in a cement grout of 40 per cent. gauge, with and without calcium chloride, were tested, tensile strengths being determined for:—

(*a*) briquettes standing one day in moist air,

(*b*) briquettes standing one day in moist air and two days under lime water,

(*c*) briquettes standing one day in moist air and six days under lime water.

The usual type of tensile strength tester was used. Results are given in Table VIII. :—

TABLE VIII.

Effect of Lime on the Tensile Strength of a Cement.

Lime.	40% gauge with no calcium chloride. Tensile strength in lbs./sq. in. after			40% gauge with 3% calcium chloride. Tensile strength in lbs./sq. in. after		
Per cent.	1day.	3 days.	7 days.	1 day.	3 days.	7 days.
Nil.	292	361	463	296	418	439
0·2	297	374	443	288	421	431
0·4	302	387	437	301	439	439
0·6	280	399	462	304	408	448
0·8	277	395	449	301	399	457
1·0	284	381	457	305	440	455

From these results it is seen that :—

(*a*) lime in percentages up to 1 per cent. in a mix with no calcium chloride has little effect on tensile strength after one day.

(*b*) It seems to very slightly increase the tensile strength after three days but scarcely to alter the seven days strength in mixes containing no calcium chloride.

(*c*) Mixes containing calcium chloride seem to be little affected by small percentages of lime, as far as tensile strength goes, any tendency being, apparently, to increase the strength.

Sufficient supplies of "Diatomite" were not available to make comparative tests of tensile strength.

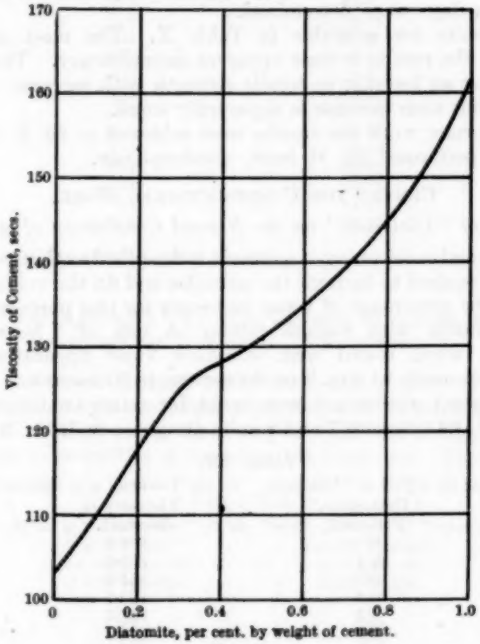


FIG. 2.

EFFECT OF SMALL QUANTITIES OF DIATOMITE ON THE VISCOSITY OF A 40 PER CENT. CEMENT GROUT.

EFFECT OF "DIATOMITE" ON THE VISCOSITY OF 40 PER CENT. CEMENT GROUT.

The method of determination was similar to that described above. All results were obtained at 80° F. and every result was the average of at least six determinations checking to within 3 per cent. of error.

Results are given in Table IX and expressed graphically in Fig. 2.

Synopsis of Results of Tensile Strength Tests on 40 per cent. Cement Grouts containing Various percentages of "Diatomite."

Cement and various percentages of "Diatomite" were mixed together by hand and then gently ground in an agate mortar till no white specks of "Diatomite" were visible in the mix. These mixtures were then mixed with 40 per cent. of water (by weight of cement) and placed in briquettes. The tensile strengths after one, three and seven days were determined.

The results are available in Table X. The most noticeable feature of the results is their apparent inconsistency. The general trend is for an increase in tensile strength with increase of "Diatomite," but such increase is apparently small.

As in former work the results were achieved at 80° F. and each test was performed in, at least, quadruplicate.

Cement for Constructional Work.

Influence of "Diatomite" on the Normal Consistency of a Cement.

The normal consistency of a cement is described as that percentage of water required to hydrate the particles and fill the voids between them. The percentage of water necessary for this purpose is found by experiment with various mixes. A mix of "Normal Consistency," when tested with standard Vicat apparatus, allows the needle to sink 10 mm. into the cement in 30 seconds.

The normal consistency was found for mixes containing up to 8 per cent. "Diatomite," and results are given in Table XI.

Table IX.

Showing the Effect of "Diatomite" on the Viscosity of a Cement Grout.

"Diatomite." Per cent.	Viscosity in seconds.
0·0	108·5
0·1	118·0
0·2	124·9
0·3	130·5
0·4	135·5
0·5	139·2
0·6	142·0
0·7	145·3
0·8	152·1
0·9	160·4
1·0	166·6

Table X.

Time.	Tensile strength in lbs./sq. in. for 40% gauge grouts containing the following percentages of "Diatomite"										
Days.	Nil.	0·1	0·3	0·5	0·7	0·9	1·0	1·5	2·0	2·5	3·0
1	239	214	243	253	220	248	263	263	267	221	239
3	383	366	356	364	351	352	338	374	400	351	404
7	401	438	447	458	439	414	427	418	Not yet completed		

TABLE XI.

Effect of "Diatomite" on the Normal Consistency of Cement.

"Diatomite" per cent. by wt. of dry cement.	Per cent. water to give normal consistency.
0·0	22·25
0·5	22·5
1·0	22·8
1·5	23·25
2·0	23·9
2·5	24·75
3·0	25·5
3·5	26·5
4·0	27·5
4·5	28·25
5·0	28·75
5·5	29·25
6·0	29·75
6·5	30·25
7·0	30·75
7·5	31·25
8·0	31·75

Further work is needed here.

EFFECT OF "DIATOMITE" ON THE TENSILE STRENGTH OF CEMENT GROUTS OF "NORMAL CONSISTENCY."

Seven-day tensile strength tests were made on mixes of "Normal Consistency" which contained percentages of "Diatomite" up to 8 per cent. Results are available in Table XII. and in Fig. 3. Again the change in properties of the cement at 1 per cent. "Diatomite" is noted.

TABLE XII.

Effect of "Diatomite" on the Tensile Strength of Cement.

"Diatomite," per cent. by wt. of dry cement.	Tensile strength in lbs./sq. in. after 7 days.
0·0	754
0·5	769
1·0	802
1·5	778
2·0	734
2·5	695
3·0	664
3·5	639
4·0	619
4·5	603
5·0	592
5·5	584
6·0	578
6·5	573
7·0	569
7·5	565
8·0	562

Summary and Conclusions.

(*a*) Experimental work on the effect of hydrated lime and "Diatomite" has shown that these substances in all proportions seem to increase the *viscosity* of a cement grout. In the case of cement for structural use they might be used to make the material more workable.

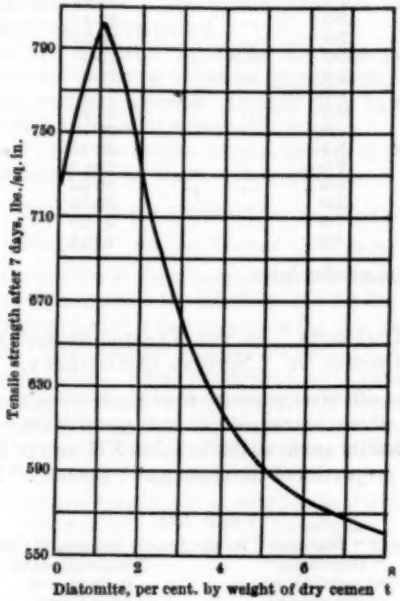


Fig. 3.

Effect of Diatomite on the Tensile Strength of Cement.

(*b*) Experiments on the effect of lime on setting time and tensile strength show that this substance has but a small effect, the tendency being to slow down the initial and final setting times and to increase the tensile strength slightly up to 7 days. These results are in line with Ecker's pronouncement (*loc. cit.*) that up to 20 per cent. of lime may increase tensile strength.

Note.—These results are published by the courtesy of the Burmah Oil Company in the hope that they will be of general value and will stimulate the interest of cement manufacturers in the special problems of oil well cements and cementing operations.

The Catalytic Addition of Gaseous Hydrochloric Acid to Unsaturated Hydrocarbons.*

By W. J. Piotrowski and J. Winkler.

Unlike the paraffin and naphthene hydrocarbons, the unsaturated hydrocarbons of the type C_nH_{2n} are seldom found in nature. The growth of the cracking industry has been responsible for the production of large quantities of unsaturated hydrocarbons, thus creating a basis for an organic synthetic industry. The unsaturated hydrocarbons, apart from the little reactive naphthene and paraffin compounds, are more responsive to chemical reactions, and owing to the double bonding they are particularly suitable for the manufacture of chemical products of industrial value.

Previous papers published by the authors have dealt with the production of larger quantities of unsaturated hydrocarbons either from gas oil[1] or from saturated gaseous aliphatic hydrocarbons.[2] The manner of their conversion into higher secondary alcohols, by their reaction under suitable conditions with sulphuric acid, was also given.[3]

The present work deals with the catalytic addition of hydrochloric acid to unsaturated hydrocarbons to obtain monochlorides which, due to their facility for exchanging an atom of chlorine for other chemical groups, are an excellent semi-raw material for further chemical syntheses.

Unsaturated hydrocarbons of the type C_nH_{2n} react with hydrogen chloride according to the general formula[4] $C_nH_{2n}+HCl \rightarrow C_nH_{2n+1}Cl$. While the addition of hydrogen iodide and even of hydrogen bromide, to olefins occurs with readiness, hydrogen chloride reacts very slowly with only a small yield of monochloride.[5] In all

* Paper received September 9th, 1930.

[1] St. Pilat and J. Winkler, *Przemysł Chemiczny*, 1929, **13**, 185.

[2] W. J. Piotrowski and J. Winkler, *Petroleum*, 1930, **26**, 763-780.

[3] St. Pilat, W. J. Piotrowski and J. Winkler, *Przemysł Chemiczny*, 1929, **13**, 209; compare also E. Holzman and St. Pilat, *Przemysł Chemiczny*, 1929, **13**, 455.

[4] Berthelot, *Annal.*, 1857, **104**, 184; 1860, **115**, 114; Schorlemmer, *Annal.*, 1873, **166**, 1777; 1879, **199**, 139; Morgan, *Annal.*, 1875, **177**, 304; Le Bel., *Compt. rend.*, 1877, **85**, 852.

[5] Erlenmeyer, *Annal.*, 1866, **139**, 228; Butterow, *Annal.*, 1868, **145**, 274; Markownikow, *Annal.*, 1869, **153**, 256; *Ber.*, 1869, **2**, 660; Sajcew, *Annal.*, 1875, **179**, 297.

cases the addition proceeds in the following manner: an atom of halogen combines with that of the carbon attached to the least hydrogen molecules (*i.e.*, by the addition of hydrogen chloride to the olefin), secondary and tertiary monochlorides being formed exclusively (Markownikow).[6] From the technical point of view, only the addition of hydrogen chloride to olefins is to be considered, and this reaction, in view of the few results published in literature, requires thorough study.

It has been stated[7] that by using pure olefins for the reaction with hydrochloric acid only a small recovery of little technical value is obtained. E. Berl and J. Bitter[8] working with ethylene, and later J. P. Wibaut[9] working with ethylene and propylene, stated that the recovery of monochlorides, working in the vapour phase, can be increased by the use of catalysts. The former worked with $AlCl_3$ deposited on silicates, and the latter used $Al\,Cl_3$, $Fe\,Cl_3$, VCl_3, $BlCl_3$, $SbCl_3$ deposited on asbestos. Although these authors worked with pure ethylene or propylene respectively, they did not obtain, even under the most favourable conditions, a higher recovery than about 36 per cent. of monochlorides.

This paper deals with efforts made to obtain secondary and tertiary monochlorides from light olefins from cracked benzine (*i.e.*, the amylene-pentane fraction). It was found that the best reaction conditions and catalyst for amylenes were generally the same as for the addition of hydrochloric acid to propylene, butylenes and hexylenes.

Initial Material.

A cheap raw material available in large quantities was cracked gasoline, particularly from systems working in the liquid phase. The lightest olefins, ethylene, propylene, and butylenes, are retained in the cracked gas, while amylenes and higher olefins are found in the gasoline. The contents of the former in the gases from the systems working in the liquid phase do not exceed 10 per cent. by volume, while the latter represent about 35 per cent. by weight

[6] Le Bel., *Compt. rend.*, 1877, **85**, 852; Stolz, *Ber.*, 1866, **19**, 538.

[7] Wagner and Sajcew, *Annal.*, 1875, **179**, 321. By the action of hydrochloric acid on amylene (obtained from diethylcarbinol) there was obtained 2-chlor-pentane. (Kondakow) Russ. I. K., *Z.*, 1893, **25**, 354, 357 who treated liquid $(CH_3)_2C{:}CH.CH_3 + {}_2Zn Cl_2$, or $C_2H_5.C.(CH_3)CH_2 + 2Zn Cl_2$ with HCl and obtained $(CH_3)_2CCl.CH_2CH_3$. Berthelot, *Annal.*, 1863, **127**, 71; Wurtz, *Annal.*, 1864, **129**, 368, effected, at 100° C., a reaction with hydrochloric acid on $(CH_3)_2CH.CH{:}CH_2$, and obtained by substitution $(CH_3)_2CH.CH.Cl.CH_3$.

[8] E. Berl and J. Bitter, *Ber.*, 1924, **57**, 95-99.

[9] J. P. Wibaut, *Z. fur Elektrochem.*, 1929, **35**, 602-605.

of the gasoline. In no case were olefins found in the pure state, but always in association with analogous hydrocarbons of the paraffin series. It is difficult to separate by fractionation either the olefin hydrocarbons from the paraffin or the particular isomers from each other. It was therefore necessary to work with mixtures consisting of some hydrocarbons of both series, boiling within definite limits; in the case of amylenes, a "well-cut" fraction boiling between 20° and 40° C. From Table I. (Beilstein) it will be seen that these boiling points cover those of the isomers of two pentanes,[10] five amylenes and one hexylene.

TABLE 1.

Hydrocarbon.	Formula.	Boiling pt. °C.	Sp. gr.
1. 2 Methylbutene (3) ..	$(CH_3)_2CH.CH:CH_2$	20·2 (749 mm. Hg.)	$d_{15°}$ 0·634
2. 2 Methylbutene (Isopentane) ..	$(CH_3)_2CH.CH_2CH_3$	30·5—31	$d_{15°}$ 0·625
3. 2 Methylbutene (1) ..	$(CH_3)CH_2C.CH_2:CH_2$	31—32	$d_{15°}$ 0·650
4. 2 Methylbutene (2) ..	$(CH_3)_2C.CH:CH_2$	35	$d_{15°}$ 0·658
5. n-Pentane	$CH_3CH_2.CH_2CH_2CH_3$	35·3 (745 mm. Hg.)	$d\frac{18°}{4°}$ 0·630
6. Pentene (2)	$CH_3CH:CH\ CH_2CH_3$	36	Unknown
7. Pentene (1)	$CH_2:CH(CH_3)_2CH_3$	39—40	,,
8. 2.2 Dimethylbutene(3)	$CH_2:CH.C(CH_3)_3$	41·2 (760 mm. Hg.)	,,

The gasoline fraction used was prepared in the following way:—

The initial raw material, a raw cracked gasoline, had the following properties:—

$$d\ \frac{15°}{4°} = 0{\cdot}733$$

Content of unsaturated hydrocarbons = 32 per cent.

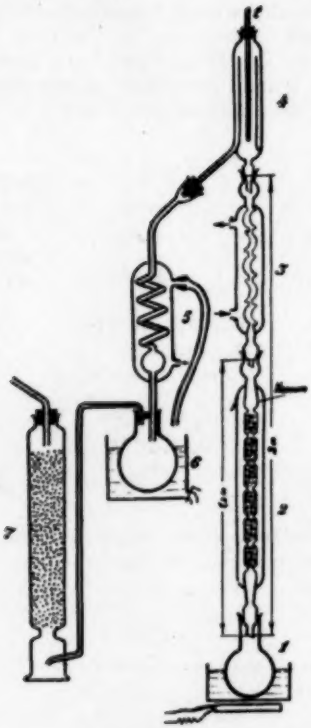
Engler distillation.

To	%	To	%	To	%
20°	5 (losses)	50°	12·5	200°	98
30°	7·5	100°	36·5	204°	99
40°	9·0	150°	66·5		

Forty litres of this were fractionated using a little column, provided with a 50-litre still, a rectifying column 5 metres high, a dephlegmator, two coolers, one for cooling with water, and the second for cooling with ice. From every 40-litre charge only one

[10] Tetramethylmethane $(CH_3)_4C$, boiling at 9·5° C. was not cited.

litre of degasified distillate was obtained, with average properties: $d\frac{15°}{4°}=0{\cdot}638$; boiling-point between 19°–56° C. This gasoline was fractionated a second time from a 1-litre flask using a Robert's



1. Boiling flask.
2. Rectifying column.
3. Deflegmator.
4. Air deflegmator.
5. Cooler.
6. Cooled receiver.
7. Tower with charcoal.

FIG. 1.

(Pyrex) rectifying column (see Fig. 1). From 1 litre, about 700 c.c. of the desired fraction was obtained and stored in a bottle main-

tained at 0° C. The material had the following properties: $d\frac{15°}{4°}$=0·632; amylenes, 31 per cent. by weight; distillation, according to Table II. and Fig. 2:

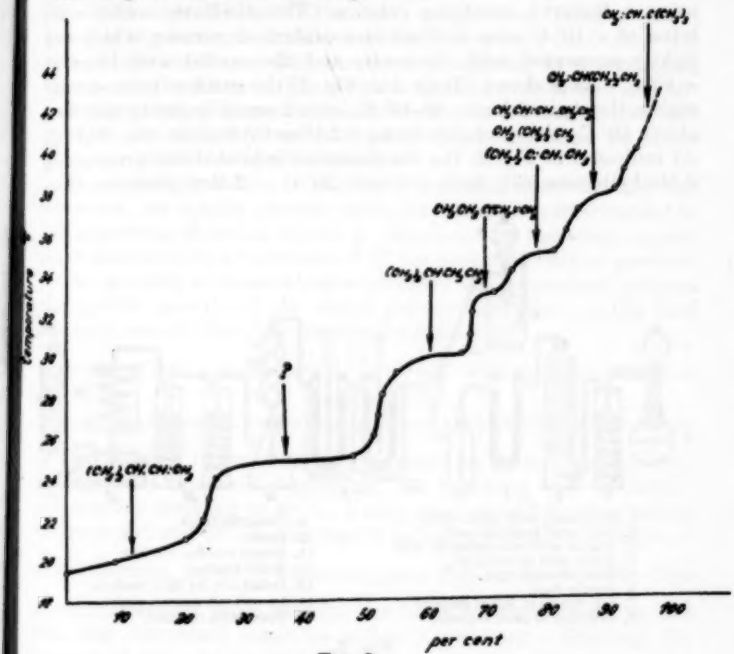


FIG. 2.

TABLE 2.

I.B.P. 19·5° C.

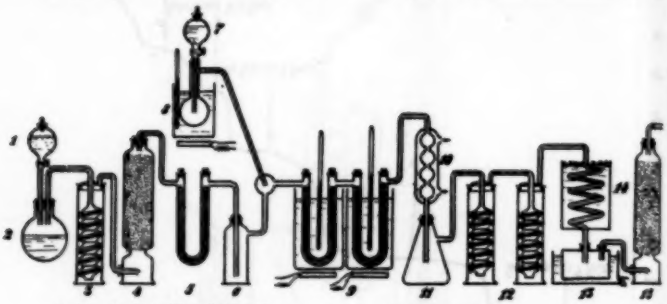
To °C.	%	To °C.	%	To °C.	%
20	8·5	28	53	36	83
21	20	29	55	37	85
22	23	30	66	38	91
23	24	31	67	39	93
24	25·5	32	67	40	94·5
25	48	33	71	43	3·5
26	51	34	74		
27	52	35	81		(residue).
				Loss	20

The amylene content was calculated from the iodine number (Wijs), assuming, as shown in Table I., that in the gasoline boiling

from 20°–40° C., the unsaturated hydrocarbons are exclusively hydrocarbons of the formula: C_5H_{10}.

The fractionation was carried out as follows:—

Two hundred cubic centimetres of the gasoline were fractionated using a Robert's rectifying column. The distillate, cooled with brine at −10° C., was received in a calibrated cylinder, which was tightly connected with the cooler and also cooled with brine at −10° C. As is shown (Table 2 or Fig. 2) the gasoline boils exactly within the desired limits 20–40° C., only a small quantity distilling above 40° C., this probably being 2.2-Dimethylbutene, (3), (C_6H_{12}). As indicated in Fig. 2, the fractionation indicated the presence of 2-Methylbutene (3), boiling about 20° C.; 2-Methylbutene (Iso-



1. Sep. funnel with sulph. acid.
2. Flask with hydrochl. acid.
3. Washer with pure hydrochl. acid.
4. Tower with m. lted $CaCl_2$.
5. Tube with dry P_2O_5.
6. Empty flask.
7. Sep. funnel w. initial gasoline.
8. Deliverer of gasol vapours.
9. Catalyzer tubes.
10. Cooler.
11. Heavy condens. receiver.
12. Water washer.
13. Cooled rec. for light condens.
14. Ice and salt mixture cooler.
15. Tower with charcoal.

FIG. 3.

pentane), boiling about 34–35° C.; 2-Methylbutene (1) and Pentane (2), boiling about 35–36° C.; and lastly Pentane (1), boiling about 39° C.

It will also be seen on Fig. 2 that between 24–25° C. an important fraction is obtained which does not correspond with any known hydrocarbon. It is possible that this is a constant boiling azeotropic mixture of 2-Methylbutene (3) and perhaps n-Pentane.

APPARATUS AND PROCEDURE.

Attempts were made to combine the hydrogen chloride with the 30 per cent. of amylene present in the above fraction, using the glass apparatus shown in Fig. 3 and 200 c.c. of pentene-amylene fraction for each experiment, the speed of throughput

being 50 c.c. per hour. The hydrogen chloride was produced in such a quantity as to be somewhat in excess, so that after the experiment the wash-bottle (12a) contained about 50 c.c. of saturated hydrogen chloride solution, while the wash-bottle (12b) contained only traces. After each experiment (lasting about 4 hours) the contents of the condenser (11), both wash-bottles (12) and of the condenser (13) were mixed together in a separating funnel cooled with ice. The aqueous solution of hydrogen chloride was separated, the gasoline washed with an ice-cooled soda ash solution and then with water until the separated water no longer gave any noticeable test for chlorine.

The washed gasolene containing the desired monochlorides was measured, its specific gravity determined, and then fractionated in the apparatus shown in Figure 1. The losses on the whole experiment amounted to a maximum of 10 per cent. of the initial gasoline.

The quantity of monochlorides obtained was determined (*a*) from the specific gravity of the initial gasoline and that of the final mixture, and (*b*) from the fractional distillation.

As the initial gasoline had d $\frac{15°}{4°}$=0·632, and the secondary and tertiary amylmonochlorides had d $\frac{15°}{4°}$= about 0·870, the contents of the latter in the reacted benzine could be determined approximately. On fractional distillation, the following were obtained: one fraction distilling to 40° C., a very small second fraction boiling between 40° and 70° C., the residue being practically a mixture of monochlorides, its d $\frac{15°}{4°}$ amounting as a rule to above 0·860. The amount obtained after allowing for losses on rectification agreed with the calculated result to within 1 per cent. Knowing the amount of monochlorides obtained in practice, the theoretical yield was reckoned according to the formula $Y=\frac{100}{31}\cdot\frac{71}{106\cdot5}\cdot X_2$, where (31) is the percentage by weight of amylenes in the initial gasoline (71) and (106·5) being the molecular weights of amylenes (C_5H_{10}) and of monochlor-pentane ($C_5H_{11}Cl$).

The Initial Investigations.

1. *The Influence of Temperature.*—According to the literature to date[11], amylmonochlorides are usually unstable and decompose to olefin and hydrogen chloride at a temperature of above 200° C. The most stable are the primary monochlorides, decomposing at

[11] E. E. Ayres, *Ind. Eng. Chem.*, 1929, **21**, 903, Table III. P. Sabatier, "Die Katalyse in der organischen Chemie," 1914, p. 200.

260° C., then follow the secondary monochlorides stable only to 180° C., the least stable being the tertiary monochlorides, which decompose at 150° C. From the above it will be seen that the highest temperature at which the synthesis of the secondary amyl-monochlorides can be carried out, is in the neighbourhood of 150° C. For the synthesis of the tertiary monochlorides, this temperature is unsuitable, as it favours the decomposition of the monochloride obtained. The application of low temperature about 70° C., although it would be very convenient for the synthesis of the tertiary monochloride, would give a very small yield of the secondary monochlorides on account of the slowness of the reaction. Using one of the catalysts tested later, the following results were obtained at the three temperatures shown :—

Table 3.

Temperature.	Percentage of theoretical recovery.	Remarks.
70° C.	35%	Almost exclusively tertiary monochloride.
100° C.	23%	Secondary monochlorides are predominant.
150° C.	40%	" " "

Using two tubes filled with the same catalyst (*a*) the first maintained at 150° C., and the second at 70° C., and (*b*) the first maintained at 70° C., and the second at 150° C., the following results were obtained :—

Table 4.

Temperature.	Percentage of theoretical recovery.	Remarks.
150° C., 70° C.	70%	Mixture of all possible monochlorides.
70° C., 150° C.	45%	Secondary monochlorides are predominant.

From Table 4 it will be seen that the application of the double temperature of reaction in the direction, higher-lower temperature, is very convenient, whereas the reverse direction of temperature gives almost the same results as by the application of higher temperature alone. This indicates the following course of reaction : at the higher temperature, secondary monochlorides form. Tertiary monochlorides form later on at the lower temperature, at which the secondary monochlorides do not undergo any change. This conclusion is proved by experiment 5 (Table 4), where the tertiary monochloride was probably formed at the lower temperature, but decomposed partially at the higher temperature. Secondary monochlorides were also formed at the higher temperature, so that the final result does not differ much from the results of experiment 3 (Table 3). In view of the above, in all further experiments the "two limiting temperatures" 150–70° C. were adopted.

2. *The Influence of Moisture.*—A study of the literature[12] shows that the presence of moisture is not harmful but is desired. Initial experiments, however, proved that a drying of hydrogen chloride is advisable, for under similar conditions the following results were obtained :—

TABLE 5.

	Percentage of recovery (calculated).	Remarks.
1. Moist HC_1	55% ..	Few of the tertiary monochlorides.
2. Dried HC_1	70% ..	All possible monochlorides present.

It would appear that moisture hinders the synthesis of tertiary monochlorides, and therefore further work was carried out with dried hydrogen chloride.

III. Investigations concerning the influence of catalysts.—The first experiment without using catalysts proved that the velocity of reaction between the amylenes and hydrogen chloride is very small, so that the recovery of monochlorides was insufficient (Table 6, expt. I).

The first catalyst used was a highly active carbon, and in view of the favourable results obtained (Table 6, expt. 2) all metallic catalysts were placed on active carbon. Experiments were made with the following metallic chlorides :

1. Secondary chlorides, $HgCl_2$, $CuCl_2$, $MnCl_2$, $CdCl_2$, $ZnCl_2$.
2. Tertiary ,, $CrCl_3$, $FeCl_3$, $BiCl_3$, $SbCl_3$, $AlCl_3$.
3. Tertiary ,, $SnCl_4$.

IV. Preparation of the catalyst.—A weighed quantity of dried active carbon was saturated with a concentrated solution of the chloride until the dry carbon contained about 20 per cent. by weight of metallic chloride. Using hydrolysing chlorides, free hydrochloric acid was added, whereas $SnCl_4$ was applied to saturation, fuming, dehydrated and in the liquid state. The carbon, saturated to the desired extent, was dried for some hours at 150° C. to constant weight and then introduced into the reaction tube. Before each experiment a stream of hydrogen chloride was passed through for a quarter of an hour and the gasoline was dropped into the flask at the velocity already mentioned (50 c.c. per hour).

V. The polymerising effect of the catalysts.—As a preliminary, experiments were carried out in order to determine whether the

[12] Michael and Zeidler, *Ann.*, 1911, **385**, 270 ; Aschan, *Ber.*, 1918, **51**, 1305, combined HC_1 with trimethylethylene in the presence of water, acetic acid or ether. Compare also D. R. P. No. 279,955, *Centrbl.*, 1914, II., 1214.

catalysts themselves without the presence of HCl would polymerise the amylenes. For this purpose, the benzine vapour was passed through the catalyst in question and any change noted, the following catalysts being examined: active carbon $+CuCl_2$, active carbon $+ZnCl_2$, active carbon $+AlCl_3$ and active carbon $+SnCl_4$.

In all cases neither the density nor the boiling range of the gasoline showed any change, this proving that the catalysts themselves did not change the benzine.

Table 6 gives the results obtained with the catalysts quoted previously.

TABLE 6.

	Catalyst.	Temperature of operation.	Theoretical recovery of chlorides.	Boiling ranges of the chlorides obtained.	Remarks.
		° C.	%	° C.	
1.	Without catalyst (empty reaction tube)	150—70	5	85—90	Almost exclusively tertiary monochlorides.
2.	Active carbon ..	„	16	85—95	Tertiary monochlorides predominant.
3.	„ $+HgCl_2$ ..	„	30	85—95	„
4.	„ $+CuCl_2$ ..	„	41	85—95	„
5.	„ $+MnCl_2$ ..	„	43	85—97	„
6.	„ $+CdCl_2$ ..	„	41	85—97	„
7.	„ $+ZnCl_2$ ..	„	70	85—115	Mixture of almost all monochlorides.
8.	„ $+CrCl_3$ ..	„	17	85—90	Almost exclusively tertiary monochlorides.
9.	„ $+FeCl_3$ ..	„	19	85—90	„
10.	„ $+BiCl_3$ ..	„	40	85—97	Tertiary monochloride predominant.
11.	„ $+AlCl_3$ ..	„	39	85—97	„
12.	„ $+SbCl_3$ ..	„	44	85—97	„
13.	„ $+SnCl_4$ ..	„	97	85—115	Mixture of all monochlorides.

Based upon the above results the catalysts examined can be divided into three groups: (1) Non-active $CrCl_3$, $FeCl_3$, (2) moderately active: $HgCl_2$, $CuCl_2$, $CdCl_2$, $MnCl_2$, $BiCl_2$, $AlCl_3$, $SbCl_3$, and (3) highly active: $ZnCl_2$, $SnCl_4$.

The addition of the first group to carbon does not increase its activity, the second group shows a considerable activity, and the third group, particularly $SnCl_4$, synthesises almost quantitatively monochlorides from amylenes and HCl. The differences in effect are not only quantitative but also qualitative. The active carbon alone and with the catalysts of the first group synthesises, almost exclusively, tertiary chlorides. Catalysts of the second group form secondary chlorides partially, whereas the last group, as the quantitative reaction indicates, effects this with greater ease.

As the last catalyst ($SnCl_4$) gave a quantitative reaction, the search for other suitable catalysts was discontinued, although it was presumed that other polychlorides such as $MoCl_5$, UCl_4, $SbCl_5$, WCl_4, VCl_4, $TiCl_4$ and $SiCl_4$ would be active in a similar manner.[13]

Larger scale work was then undertaken in order firstly to obtain about one kg. of monochlorides, and secondly to determine whether the catalysts concerned tended to lose their activity after longer use. Thirdly, it was intended to obtain a considerably quantity of a mixture of monochlorides in order to fractionate them and to determine their quantitative proportion and to characterise them chemically.

With regard to the diminution of activity of the catalysts it was observed that, after the fourth experiment with 200 c.c. of gasoline, the calalysts began to become poisoned, as was shown by the lowering of the specific gravity of the reacted gasoline. This is illustrated in Table 7.

TABLE 7.

Active carbon + $ZnCl_2$.				Specific gravity of the reacted gasoline.
To the first	200 c.c. of initial gasoline	..	..	0·690
„ second	„ „	..	..	0·690
„ third	„ „	..	..	0·690
„ fourth	„ „	..	..	0·675
„ fifth	„ „	..	..	0·665

The poisoned catalyst was removed from the tubes and attempts were made to regenerate it by blowing with superheated steam, a few c.c. of very ill-smelling yellow oil emulsified with water being obtained. An investigation of this oil showed it to be an organic sulphur compound. It is evident that the reduction of activity of the catalyst is due to the small quantity of sulphur compounds (chiefly mercaptans) which are present in the initial benzine. It was found that poisoning could be avoided by adding before the catalyst tube proper another tube with active carbon already partially poisoned.

(*a*) *Experiment with active carbon + $ZnCl_2$.*—Two litres of gasoline were treated, there being obtained after a careful rectification 450 c.c. of a mixture of chlorides boiling from 85° to 115°C. of $d\frac{15°}{15°}=0·8705$. If an unavoidable 10 per cent. of losses be counted, the theoretical recovery will equal 73 per cent. This is in good agreement with the result found previously (see Table 6).

[13] The present investigation with some of the above-mentioned chlorides prove this supposition.

In the untreated residue of distillate boiling under 40°C. there was present 8·1 per cent. of unsaturated hydrocarbons (determined by iodine number). This, calculated as non-reacted olefins, equals 26 per cent. by weight, and corresponds to the theoretical recovery of 76 per cent. of chlorides.

(*b*) *Experiment with active carbon+$SnCl_4$.*—Treating one litre of gasoline, 260 c.c. of a mixture of chlorides boiling from 85°–115°C. of $d\frac{15°}{15°}=0.8710$ was obtained. The addition of 10 per cent. of losses gives an almost theoretical recovery of 97 per cent., this agreeing with the recovery noted before in Table 6.

The iodine number of the non-reacted distillate showed the percentage of unsaturated hydrocarbons to be equal to 1·2 per cent., the non-reacted olefins being equivalent to 4 per cent.

The Separation and Determination of the Secondary and Tertiary Monochlorides.

As it will be seen from Table 1, the pentane-amylene fraction may theoretically contain 5 amylenes and 2·2 dimethylbutene in small quantities. According to Markownikow's principle the chlorine-atom always attaches itself to the least hydrogenated carbon atom, and therefore the number of possible monochlorides decreases to five as is shown in Table 8.

Table 8.

Formula of the initial amylene.	Formula of the chloride formed.	Boiling point. °C.	Specific gravity.
1. $(CH_3)_2C{:}CH.CH_3$ 2. $CH_2{:}C(CH_3)CH_2CH_3$	$(CH_3)_2CCl.CH_2CH_3$	86	d 15—0·870
3. $(CH_3)_2CH.CH{:}CH_2$ ..	$(CH_3)_2CH_2CHCl.CH_3$	91 (753 mm. Hg.)	d 15—0·873
4. $CH_2{:}CH.CH_2CH_2CH_3$..	$CH_3CHCl(CH_2)_2CH_3$	96—97 (746 mm.)	d 15—0·886
5. $CH_3CH{:}CH.CH_2CH_3$ ..	$CH_3CH_2CHCl.CH_2CH_3$	96	Not given
6. $(CH_3)_2C.CH{:}CH_2$ ..	$(CH_3)_2C.CH.ClCH_3$	113—114	"

In the final product there may be present: one tertiary amyl-chloride boiling at 86°C.; three secondary amyl-chlorides boiling at 91°C. and 96°–97°C., and lastly, secondary hexylchloride boiling at 113°–114°C. As the mixture boiled between 85° and 115°C., all the above chlorides could be expected to be present. In order to separate them, 700 c.c. of chlorides obtained by the experiments with active carbons $+SnCl_2$ and active carbon

$+ZnCl_2$ were mixed and fractionated with the Robert's column. Table 9 and also Figure 4, give an idea of the fractionation.

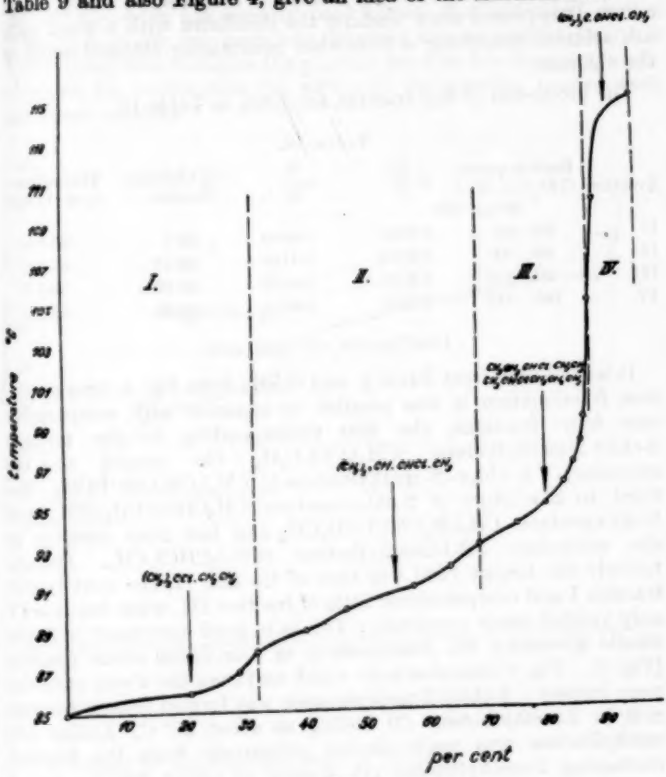


FIG. 4.

TABLE 9.

Initial boiling point 85° C.			to 94°	75%	
to 86°	21%		„ 95	80%	
„ 87	29%	Fraction I.	„ 96	83%	Fraction III.
„ 88	32%	(32%)	„ 97	84·5%	(12%)
„ 89	40%		„ 98	86%	
„ 90	47%		„ 100	86·5%	
„ 91	58%	Fraction II.	„ 105	87%	
„ 92	64%	(37%)	„ 110	88·5%	Fraction IV.
„ 93	69%		„ 115	95%	(7%)

The residue (3 per cent. by vol.) was a dark liquid with a sharp smell of hydrogen chloride. The distillate also had a slight smell

of hydrogen chloride evidently resulting from a slight decomposition of the chlorides due to being heated in the flask to 150°C. The odour disappeared after washing the distillates with a weak soda ash solution displacing a somewhat penetrating ethereal smell of the chloride.

The properties of this fraction are given in Table 10.

TABLE 10.

Fraction.	Boiling point (742 mm. Hg.) ° C.	$d\frac{15°}{15°}$	n_D^{20}	% Chloride (Carius).	Theoretical % of chloride
I. ...	85—88	0·8628	1·4080	33·1	33·3
II. ..	88—93	0·8703	1·4100	33·15	33·3
III. ..	93—105	0·8816	1·4162	32·95	33·3
IV. ..	105—115	0·8867	1·4231	32·25	32·08

DISCUSSION OF RESULTS.

It will be seen from Table 9, and chiefly from Fig. 4, that on the first fractionation it was possible to separate with comparative ease four fractions, the first corresponding to the tertiary 2-chlor-2-methylbutene $(CH_3)_2CCl.C_2H_5$, the second to the secondary 3-chlor-2-methylbutene $(CH_3)_2CH.CHCl.CH_3$, the third to a mixture of 2-chlor-pentane $CH_3CHCl(CH_2)_2CH_3$ and 3-chlorpentane $CH_3CH_2CHCl.CH_2CH_3$ and last very possibly to the secondary 2.2-Dimethylbutene $(CH_3)_3CHCl.CH_3$. Quantitatively the largest yield was that of fraction II, the next largest fraction I and comparatively little of fraction III, while fraction IV only yielded small quantities. This is in good agreement with the results given by the fractionation of the initial crude gasoline (Fig. 2). Fig. 2 indicates from which amylenes the above chlorides were formed: 3-chlor-2-methylbutene was formed from a fraction rich in 2-methylbutene (3) boiling at about 20° C., 2-chlor 2.2-methylbutene was made almost exclusively from the fraction containing 2-methylbutene (1), boiling at about 320° C., and a small quantity from the narrow fraction of 2-methylbutene (2) boiling about 35° C. Fraction III possibly contains (3) chlorpentane obtained from pentane (2) boiling at 36° C., for the quantity of pentane (1) boiling at 39°–40° C. (Figure 2) is comparatively small. Lastly, the small fraction IV was formed from 2·2-Dimethylbutene boiling above 40° C. Present work concerns the further purification of the fraction obtained for the determination of the physical constants of the secondary and tertiary monochlorides obtained directly from unsaturated hydrocarbons. As will be seen from the literature (Beilstein, etc.), they are almost entirely uncharacterised.

Identification of the Fraction free from Amylenes boiling from 20°-40° C.—As it has already been shown that activated carbon $+SnCl_4$ converts amylenes into chlorides almost quantitatively, it was decided to investigate the pentane fraction free from amylenes, obtained by rectification (to 40° C.) of the gasoline treated with the above catalyst.

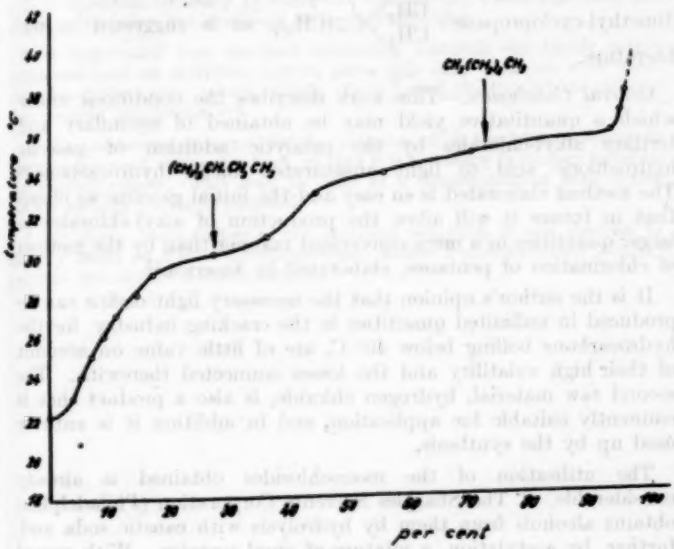


FIG. 5.

The details of this fraction were as follow:

(1) $d\,\frac{15}{4} = 0{\cdot}6334$, (2) unsaturated hydrocarbons 1·2% by weight, (3) fractional distillation using Robert's apparatus.

Initial boiling point 22° C.

23° ..	4%	28° ..	14·5%	33° ..	44%	37° ..	94 %
24° ..	5%	29° ..	17·0%	34° ..	55·5%	38° ..	94·5%
25° ..	7%	30° ..	27·0%	35° ..	70·0%	Residue	2·5%
26° ..	9%	31° ..	36·0%	36° ..	93·5%	Loss ..	3·0%
27° ..	11%	32° ..	40·0%				

Comparing Fig. 5 with the distillation of initial gasoline (Fig. 2), it can immediately be seen that from the former mixture of about

eight hydrocarbons there remained only two: *i.e.*, isopentane boiling at about 30° C. and n-pentane boiling at 35°-36° C. The unknown fraction boiling at 24°–25° C. disappeared almost completely, this proving the former supposition that it consisted of an azeotropic mixture of some unsaturated and saturated hydrocarbons. The presence of the narrow fraction, boiling at 22° C. makes it possible that the gasoline may perhaps contain dimethyl-cyclopropane: $\begin{matrix}CH_2\\CH_2\end{matrix}\!\!>\!C.(CH_3)_2$, as is suggested in the literature.

General Conclusion.—This work describes the conditions under which a quantitative yield may be obtained of secondary and tertiary alkyl-chlorides by the catalytic addition of gaseous hydrochloric acid to light unsaturated olefin hydrocarbons.[14] The method elaborated is so easy and the initial gasoline so cheap that in future it will allow the production of alkyl-chlorides in larger quantities in a more convenient manner than by the method of chlorination of pentanes, elaborated in America.[15]

It is the author's opinion that the necessary light olefins can be produced in unlimited quantities in the cracking industry, for the hydrocarbons boiling below 40° C. are of little value on account of their high volatility and the losses connected therewith. The second raw material, hydrogen chloride, is also a product that is eminently suitable for application, and in addition it is entirely used up by the synthesis.

The utilisation of the monochlorides obtained is already considerable. "The Sharples Solvents Corporation (Philadelphia) obtains alcohols from them by hydrolysis with caustic soda and, further, by acetylation, a mixture of amyl-acetates. With regard to the comparatively easy substitution of the chlorine atom, a new field for application can be opened up for the synthetic organic chemical industry. From ethylene and propylene, for which the methods described are also suitable, low boiling chlorides may be prepared, the method described herein being cheaper than that of the more difficult chlorination of pentanes.[16]

---

[14] Announced for the D.R.P., E.P., U.S.A., etc., patent protection.

[15] In U.S.A. the above chlorides are obtained as a semi-raw material by the chlorination of pentanes. Compare C. E. Ayres, *loc. cit.*; L. H. Clark, *Ind. Eng. Chem.*, 1930, **22**, 439.

[16] By this last process only half the chlorine is used, the second half forming hydrogen chloride, which has no futher application in the later stages.

SUMMARY.

1. It was found that the optimum temperature of the addition of hydrogen chloride to olefins lies between 70°–150° C. It is convenient to work at least at two limiting temperatures, in the order higher–lower. The higher temperature favours the synthesis of secondary chlorides, whereas the lower temperature suits the synthesis of tertiary chlorides.

2. It appeared necessary to work with entirely dry initial materials, the moisture hindering the synthesis of tertiary chlorides.

3. It was found that the best contacting materials are highly active substances such as activated carbon, silica gel, etc., saturated with polychlorides of the heavy metals, chiefly ($ZnCl_2$) and ($SnCl_4$) (which catalyse this reaction quantitatively).

4. The contacting material in the presence of the sulphur compounds becomes poisoned after some time, so that it is necessary to remove it before the contact proper. This may be done in a simple manner with active carbon already partially poisoned.

5. By sharp fractionation of the chlorides obtained, it was possible to identify them as 2-chlor-2-methylbutene, 3-chlor-2-methylbutene, 2-chlorpentane and 3-chlor-2-methylbutene.

A Constant Level Consumption Meter for Lamps.*

By R. Downer, B.Sc.

The apparatus to be described is one which was devised for the purpose of obtaining an accurate volumetric measure of consumption on an experimental lamp specially designed for research into the nature of the burning of kerosine in wick-fed lamps. A specification was drawn up for the working of the proposed apparatus and can be enunciated as follows :—

(1) Constancy of oil level in the oil chamber, *i.e.*, the height of exposed wick (above liquid level) to be constant for a given wick setting.

(2) An oil consumption reading of accuracy within 1 ml. per hour.

(3) The apparatus to become adjusted accurately to changed conditions imposed by the operator, such as alteration in wick setting or draught, within a period of five minutes.

Apparatus.

The apparatus depends for its working upon a syphon of constant head drawing from a source of liquid at constant level. A is an air-tight chamber, preferably a 2-litre pear-shaped vessel, containing the main supply of oil for consumption. This is fused into a glass chamber B from which emerges a syphon bend C containing a capillary at D. In turn this is connected to another cylindrical glass chamber G which is sealed to the bottom of B, as shown in the diagram. To the opposite side of G is joined a syphon bend L with capillary at M cooled by condenser N with water at constant temperature. The tube O passes into a limb P, with which the lamp constitutes a U tube, and a graduated overflow tube Q is attached to it. F_1, F_2 and F_3 are air vents and by means of tubes K_1 and K_2, controlled jointly by the cock K, vessels B and G may be drained. There are two cocks, X_1 and X_2, not shown in the diagram, which are joined to the chambers B and G respectively so that they are opposite the levels of liquid indicated.

Operation.

The main reservoir A is filled with the oil to be burnt in the lamp and made air-tight by means of stopper provided. Cocks X_1 and X_2 are turned off and the cock at A_1 and E turned on. Oil passes from A into chamber B and this fills to the level indicated when A_1 is turned off. Pressure is applied at F, and the kerosine is blown over through capillary D flowing to vessel G.

* Paper received January 10th, 1931.

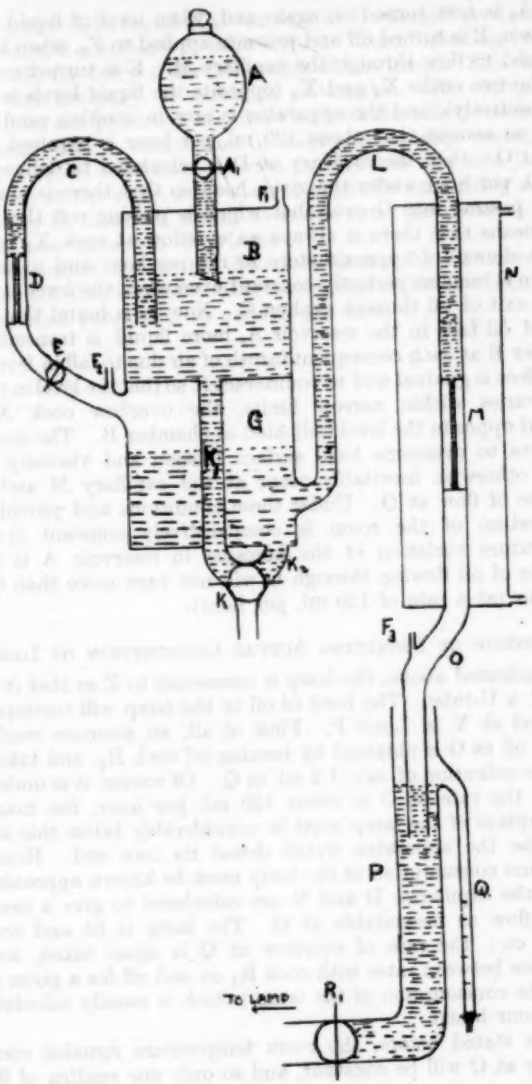


FIG. 1.

Cock A_1 is now turned on again and, when level of liquid in G is as shown, E is turned off and pressure applied to F_2, when kerosine is caused to flow through the capillary M. E is turned on again, also the two cocks X_1 and X_2 (opposite the liquid levels in B and G respectively), and the apparatus is now in working condition.

Let us assume that about 120 ml. per hour is required to flow past at O: then the capillary at D is calculated to deliver about 140 ml. per hour under the given head so that there is always an excess passing into G over that which is passing out through M. This means that there is always an overflow at cock X_2 in vessel G (not shown) of approximately 20 ml. per hour and so the level of oil in G remains perfectly constant even when the level at B falls due to exit of oil through syphon C. Now it is found that as the level of oil falls in the reservoir A, more liquid is transmitted to chamber B at each consequent inrush of air due to fall in level of B. This effect is gradual and to counteract it so that the level in vessel B only varies within narrow limits, the overflow cock X_1 was inserted opposite the level indicated in chamber B. The condenser N serves to overcome local surface tension and viscosity effects which otherwise inevitably occur at the capillary M and affect the rate of flow at O. Under these conditions and provided the temperature of the room is comparatively constant (*i.e.*, the temperature variation of the kerosine in reservoir A is small), the rate of oil flowing through O will not vary more than 0·3 ml. per hour (at a rate of 120 ml. per hour).

Method of Obtaining Actual Consumption of Lamp.

As indicated above, the lamp is connected to Z so that it forms, with P, a U-tube. The level of oil in the lamp will correspond to the level at Y in Limb P. First of all, an accurate reading of flow of oil at O is obtained by turning off cock R_1, and taking the time for collection of, say, 1·5 ml. in Q. Of course, it is understood that if the rate at O is about 120 ml. per hour, the maximum consumption of the lamp must be considerably below this amount otherwise the apparatus would defeat its own end. Hence the maximum consumption of the lamp must be known approximately before the capillaries D and M are calculated to give a necessary excess flow as measurable at Q. The lamp is lit and cock R_1 turned on: the rate of overflow at Q is again taken, and the difference between rates with cock R_1 on and off for a given period gives the consumption of the lamp (which is usually calculated on a one-hour basis).

If, as stated before, the room temperature remains constant, the flow at O will be constant, and so only one reading of flow at O will be necessary for a set of experiments. But if the temperature

changes, it will be found that the rate at O changes gradually and so it becomes necessary to take a fresh "Zero" reading (with R_1 turned off) for every different setting of the lamp. This does not affect the accuracy of readings obtainable. The temperature factor does not present a real drawback to the effectiveness of the apparatus, but it seems that it might be readily overcome by having a spiral condenser inserted in Vessel G and also jacketing the whole of the syphon L, when it might be reasonably assumed that oil in G, L and M would be of the same temperature despite temperature variations elsewhere.

In conclusion, the writer desires to thank the Directors of the Burmah Oil Co., in whose laboratories this work has been carried out, for kind permission to publish this note.

CURRENT PETROLEUM NOTES.

Petroleum Operations in New Zealand.—During recent years thirty-four wells in search of oil have been drilled, the deepest being at Moturoa, which reached a depth of about 6000 ft. Up to the present borings in the Dominion have only obtained a small and intermittent flow.

An effort was made to recondition the Blenheim well, the intention being to clear it to 2180 ft., from which depth 30,000 gals. of oil were obtained in 1914, and then to "shoot" it. The well was cleared to 2200 ft. and in February, 1929, oil was struck and about 14,000 gals. produced. In March a blow-out occurred and the well was abandoned. A second well is being drilled and has reached a depth of 2100 ft.

The Taranaki (N.Z.) Oilfields have suspended work in the Taranaki district and their two wells at Tarata and Moturoa had, at the end of 1926, reached 5010 ft. and 4360 ft. respectively without finding payable oil or gas.

Field-work was done in the Gisbourne district in 1925 and drilling commenced in 1926. Waipu Nos. 1 and 2 wells reached depths of 2540 and 3260 ft. before drilling was stopped, but encountered no oil. Gisbourne No. 1 well was continued to 3040 ft. and No. 2 reached 3180 ft. In both cases caving strata stopped the drilling and rotary plant is to be installed at the latter well. Both wells had shows of gas and oil.

Drilling was commenced in 1926 near the Mangles River in the Murchison district, and had reached a depth of 4080 ft. in 1928, when work was suspended. Gas and a show of oil were met with at 2300 ft.

Coal Oil (N.Z.), Ltd., has carried out geophysical work in the Taranaki district and has commenced a well with an initial diameter of 21 in. in the Omata area. This well has reached 2038 ft.

The New Zealand Oil Syndicate has abandoned its Prospect No. 1 well at Whangamomona at 931 ft. A second well nearby has reached 1258 ft. with traces of oil at 900 and 1010 ft.

The Oil and Gas Syndicate has cleared the old rotary well at Moturoa to 1640 ft. and obtained a continuous flow of gas. Equipment for recovery of oil from the gas has been erected.

The Moturoa Oil Fields, Ltd., have drilled a well to 2122 ft. at Moturoa, and the Whanga Petroleum Prospecting and Development Co., Ltd., to 640 ft. at Aotuhia.—*New Zealand Official Year-Book*, 1931.

Production of Natural-Gas Gasoline.—The world's production of natural gasoline amounted to 41,470,069 brls. in 1927, 47,023,551 brls. in 1928, and 58,200,357 brls. in 1929. Of these amounts the quantities produced in the U.S.A. were 39,074,857 brls. in 1927, 43,191,286 brls. in 1928, and 53,183,048 brls. in 1929. The largest producer in the other countries was the Dutch East Indies with 779,143 brls. in 1927, 1,062,160 brls. in 1928, and 1,333,926 brls. in 1929.—*U.S. Bureau of Mines.*

Production of Liquefied Petroleum Gases.—The quantity of liquefied petroleum gases, chiefly butane and propane, marketed in the U.S.A. during 1930 was 18,017,347 gals., nearly double the figure of 9,930,964 gals. in 1929, and nearly four times as much as the 4,522,899 gals. in 1928. The distribution of propane was about 11,500,000 gals., and of butane, pentane and butane-pentane mixtures about 6,500,000 gals.

In territories not served by gas mains, propane is transported as a liquid in cylinders and is commonly known as "bottled gas."

Butane is principally sold for industrial uses, particularly when the demand is too small to support a gas service of the manufactured or natural type.—*U.S. Bureau of Mines.*

REVIEWS.

ERDOL UND VERWANDTE STOFFE. Dr. R. Koetschau, Dresden and Leipsic. Verlag von T. Steinkopff. 1930. Pp. vi.—150. With 32 figs., and 1 folding diagram. 8 r.m.

Although issued as a separate publication, this booklet is actually a supplement to Doelter and Leitmeier's "Handbuch der Mineral-Chemie" in the compilation of which Dr. Koetschau had collaborated with the authors. The numbering of the pages and of the figures in the text follow on from the fourth volume of the larger work which it resembles in general arrangement and style.

As explained in the author's preface, the work is not so much a contribution to the well-known technological literature of the subject as it is a scientific review of the whole field of investigation into petroleum problems.

Within the relatively short period which marks the growth of the petroleum industry, a vast amount of scientific and technical information has been accumulated by workers in all parts of the world. Dr. Koetschau has succeeded in extracting the most essential facts and significant theories from a whole library of textbooks, government publications, patent specifications and technical periodicals, and compressing his selections into the space usually occupied by a small handbook of only 150 pages.

While this has involved a miracle of scientific condensation, the work is not a mere assemblage of uncorrelated data, it has coherence and follows a certain logical sequence for which reason it is distinctly readable.

The subject-matter is divided into three parts, the first or general section, under the sub-heading of "Terminology" being devoted to an exposition of the methods adopted by various authorities for defining and classifying the naturally occurring bitumens.

In this section there is a useful list of the more important text-books and technical journals, this also serving as a bibliographical reference list for the book. It is noteworthy that the publications of our own Institution are conspicuous by their absence from the list, and that only German periodicals are mentioned.

The geology of petroleum, the geographical distribution of crude oil, drilling methods and production statistics are dealt with quite briefly, but some 12 pages are devoted to theories of origin which are commendably summarised and discussed.

The second part deals with the various types of crude, comparing them one with another on the basis of their chemical and physical properties. The analyses of a large number of typical crude oils are tabulated, some prominence being given to the extensive investigations carried out by Smith and Lane on the properties of North American oils. The tabulated results obtained by these workers form the single large folding diagram with which the book is embellished.

The third and largest section is a review of the chemistry and physics of the subject, and is subdivided into three parts dealing respectively with the mutual relationship of chemical and physical properties, special analytical values and their significance, and finally the changes produced by thermal decomposition (cracking) or by chemical reagents and catalytic reactions.

In this section viscosity and lubrication find an important place, nine pages being considered necessary for adequately reviewing the available data. Part of this space, however, is taken up by another list of books which deal specifically with the subject.

Four more pages are utilised for the consideration of surface tension and capillary constants as applied to petroleum products but the subject of adsorption and the application of its phenomena to refining problems, is dismissed in but 12 lines, although the attention of the reader is directed to a number of recently published works dealing with the subject.

The book is well printed on good paper in clear type which even in the extensive footnotes and bibliographical references is not too small for easy reading. On the other hand the usefulness of the volume would have been increased if a general index had been included.

A book of this kind will undoubtedly appeal to those chemists or scientists whose sphere of activity has not previously lead them into the highways and byways of Petroleum Technology, for it can give them the essential facts in a nutshell.

Even for seasoned petroleum technologists the little volume is to be recommended as a useful book of ready reference, while for students, especially those engaged in assimilating material suited to the exigencies of inquisitive examiners, the book should prove of immense service, out of all proportion to the very moderate purchase price.

J. McConnell Sanders.

Elements of Chemical Engineering. Professors W. L. Badger and W. L. McCabe. Chemical Engineering Series, McGraw-Hill Book Co., Inc., 1931. 25s. net. Pp. xvii+625.

The chemical engineering is concerned primarily with the design and operation of the plant that is required for carrying out such unit operations as grinding, mixing, dissolving, filtering, evaporating, distilling, drying, etc. He is also concerned with the arrangement and articulation of several unit operations in a complete process, with the lay-out of the necessary plant, as well as with the organisation and profitable operation of the complete factory. All chemical engineering practice is necessarily based upon a sound knowledge of the principles upon which the design and operation of the different unit plants are founded.

A student of chemical engineering may generally be assumed to possess a sound knowledge either of chemistry or of engineering; usually, he knows nothing about chemical plant or manufacturing conditions. It is necessary, therefore, not only to provide him with a clear and reasoned account of the theory underlying the various unit operations but also to describe for him the different kinds of plant that may be used to carry out these operations. He must also be familiar with the conditions, both technical and economic, which, in practice, determined not only whether a process is efficient, but also whether it is profitable.

Hitherto, the standard treatise on the theory of the different chemical engineering unit operations has been the well known textbook by Messrs. Walker, Lewis and McAdams. This book gives a very well arranged and complete account of the theory of the different unit operations, but does not say enough about the different types of plant and of the way in which they are constructed and used. To the student, therefore, who is not already familiar with chemical plant, the book is apt to be a little unreal in its treatment and difficult to relate with practical conditions. Messrs. Badger and McCabe have sought to remedy this deficiency by writing a book which gives a clear account of the necessary theory and also describes very fully the different types of plant that can be employed for putting the theory into practice under different sets of conditions. In many ways their book is to be preferred as an introduction to the study of the subject of chemical engineering unit operations. The book is very readable, and is extremely well illustrated by line drawings

which indicate very clearly the actual method of construction of the different types of plant. Many readers who are familiar with the earlier book will find this new one refreshing and stimulating in its treatment of familiar subjects.

The book consists of about six hundred pages, divided into seventeen chapters which contain over three hundred illustrations. After an introductory chapter which contains, amongst other things, an account of such useful mathematical methods as graphical integration and the use of log.-log. paper, there are two excellent chapters dealing with the flow of fluids and the transportation of fluids, respectively. A useful chapter follows on the flow of heat, containing a section showing the design and construction of different types of heaters. Evaporation is then dealt with fully in a chapter of some sixty-seven pages. The arrangement of the material in this chapter is typical of that in the other chapters that deal with particular unit operations :—

The different types of evaporator are classified and described ; the various factors which affect evaporative capacity are then discussed. This is followed by a series of calculations, showing how these factors are to be considered in designing a plant for a definite job. After a section dealing with the various evaporator accessories, the general conditions of evaporator operation are described. Finally, an extensive section is devoted to the principles of multiple-effect evaporation and the operation of a multiple-effect evaporator. The chapter concludes with a number of useful problems, some of which are worked out, others being left for the student to work out for himself.

Subsequent chapters deal in a similar manner with diffusion processes, humidity and air conditioning, drying, distillation, gas absorption, extraction, crystallization, filtration, mixing, crushing and grinding, size separation and conveying and weighing. The chapter on distillation (forty pages) is particularly clear and interesting. Useful information is presented in a convenient form in a series of appendices.

The book appears to be singularly free from typographical errors. Fig. 153 should be turned round, and Figs. 176A and 176B have obviously been interchanged. It is to be expected that, in an American book, the illustrations will be almost entirely of American plant, particularly when the book is dealing with a subject in which American inventors have been conspicuously successful. The chapter on crystallisation is, if anything, unnecessarily long for a book of this character ; the greater part of the space might well have been devoted, for example, to a more complete account of the industrial treatment of fumes and dusty gases, or the use of catalysts. The value of the book would be enhanced—particularly to the private reader—by appending to each chapter a list of references to the relevant literature.

The book is first rate. It provides a competent and clear account of the theory and practice of the important unit operations. It can be recommended unreservedly to students of chemistry or engineering who wish to gain some knowledge of this important neighbouring territory, to serious students of chemical engineering who need a textbook that is both lucid and interesting, and to the practising chemical engineer to remind him of the many things that he has known long since and lost awhile.

W. E. GIBBS.

BOOKS RECEIVED.

APPLIED GEOPHYSICS. Capt. H. Shaw. H.M. Stationary Office, London, 1930. Pp. 102, 10 pl. 2s. net.

The first fifty pages give a brief and valuable survey of the development of apparatus and methods employed in the investigation of subterranean structural conditions and the location of mineral deposits.

The remaining pages are occupied by a descriptive list of the various exhibits of geophysical apparatus and equipment which are on view at the Science Museum, South Kensington.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY, 1930. Pp. 745. London: Society of Chemical Industry, 1931. 12s. 6d. (7s. 6d. to Members of the S.C.I.).

The Reports of the Society of Chemical Industry on the Progress of Applied Chemistry form a valuable guide to the industrial chemist regarding the advance made during the year in the application of chemistry and chemical plant.

The present volume follows the lines of the previous volumes and the various reports, each written by an authority on the particular subject, can be read with advantage by all chemists engaged in industry.

Of particular value to petroleum chemists is the article on Mineral Oils, by Dr. A. E. Dunstan, while the reports on Fuel, by H. J. Hodsman and A. Key, and on Gas, Carbonisation, Tar and Tar Products, by James Macleod and T. A. Wilson, should also prove of interest.

CHEMICAL ENGINEERING AND CHEMICAL CATALOGUE. Edited by D. M. Newitt, London, Leonard Hill, Ltd., 1931. Pp. 363+lxiv. 15s.

The seventh annual edition of this reference book follows the lines of its predecessors. The various sections have been revised and brought up to date, and the key index has been set in French as well as in English. The book should prove of considerable value to all engaged in industries using chemical products and plant.